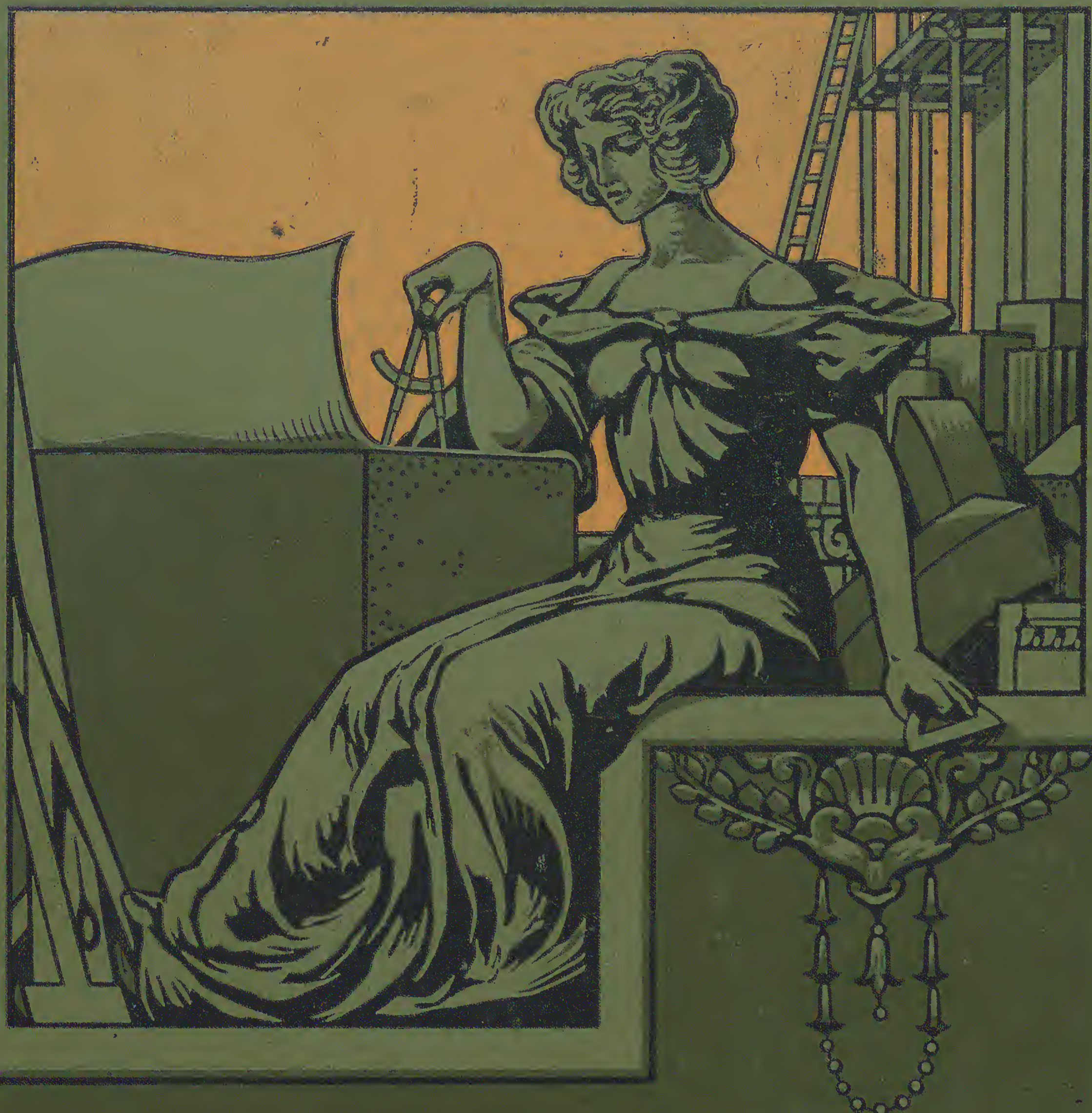

MODERN HOUSE CONSTRUCTION

MODERN HOUSE CONSTRUCTION

No. 1.

No. 2.

No. 3.

"SURREY HOLME", BYFLEET, SURREY.

1. GARDEN FRONT (South-east). 2. THE STAIRCASE. 3. THE DEN.

The Principles & Practice of
MODERN HOUSE CONSTRUCTION

INCLUDING PLAN AND DESIGN : CONSTRUCTION : WATER-SUPPLY AND FITTINGS : SANITARY FITTINGS & PLUMBING : DRAINAGE & SEWAGE-DISPOSAL : WARMING : VENTILATION : LIGHTING : STABLES & COW-HOUSES : SANITARY LAW : &c.

BY MANY LEADING SPECIALISTS
UNDER THE EDITORSHIP OF

G. Lister Sutcliffe

ASSOCIATE OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS
MEMBER OF THE ROYAL SANITARY INSTITUTE

NEW EDITION

Thoroughly revised and considerably extended

DIVISIONAL-VOLUME VI

THE GRESHAM PUBLISHING COMPANY
34 AND 35 SOUTHAMPTON STREET STRAND LONDON

For some of the Illustrations in Divisional-Volume VI., indebtedness has to be acknowledged to the following firms:—Messrs. Thos. Ash & Co., Birmingham; R. Clarke & Co., Heckmondwike, Yorks; The Proprietors of "The Lancet"; Musgrave & Co., Ltd., Belfast; Oates & Green, Ltd., Halifax; Dr. Scurfield, Medical Officer of Health, Sunderland.

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SECTION XV.

THE SANITARY INSPECTION OF HOUSES

BY

WILLIAM H. WELLS

SANITARY INSPECTOR FOR THE CITY OF NEWCASTLE-UPON-TYNE

CHAIRMAN OF THE NORTHUMBERLAND AND DURHAM BRANCH OF THE SANITARY INSPECTORS' ASSOCIATION

SECTION XV.

THE SANITARY INSPECTION OF HOUSES.

CHAPTER I.

WATER-SUPPLY.

In town houses, the water is usually obtained from the public supply, distributed through mains and service-pipes, but there are still some dwellings, even in our largest cities, provided either wholly or partially with water from wells. Generally, where such a well is retained in use, the occupier is the owner of the house, and the notion that the water of his particular well is better than the town supply has grown up with the family, perhaps from the time when the street was first provided with water-mains. This idea may have had fact for its foundation at the time of its birth, as then the house was probably suburban, and the subsoil-water not fouled by adjacent cesspools, drains, &c., and as the public supplies of some towns were, and still are, far from being pure.

The use of well-water in towns probably exists to-day from one or all of the three following causes:—

(1.) Reluctance to pay for a water-supply.

(2.) Brighter appearance and greater palatableness of the water.

(3.) Lower temperature in summer.

There are still wells in use in some town houses, the water of which is objectionable both to taste and smell, but these are very rare, and the use of the water is said to be confined to washing the floors of outbuildings and yards. This may be done, where the town supply is intermittent, to assist the cistern-storage, but where the public supply is constant, it is difficult to find a motive for retaining the use of such a well. Perhaps the custom began when the public supply, now continuous, was not so, and has been retained without thought, as the sentry who was once ordered to keep guard over a particular daisy which had attracted

a monarch's attention, was, by relief, kept walking to and fro, night and day, long after both daisy and monarch were dead, and the original reason for the lonely promenade forgotten.

In wells of the kind first referred to, the purity of the water, however lauded, should always be questioned, and permission sought **to obtain a sample for analysis.** The analysis of water is one of the most delicate operations the analyst has to perform for Sanitary Authorities. The sample therefore must be sufficient in quantity, and taken with great care. An old wine or spirit bottle, though well washed, should not be used. It is not large enough, and it may be impossible by rinsing to make it absolutely clean.

A new glass-stoppered Winchester-quart bottle (five pints), or one which has been used only for water-analysis, should be employed. The water must be obtained in the way ordinarily in use by the occupiers of the houses,—by pumping, for instance, if there is a pump, and not by lowering the bottle into the water. It must also be received direct into the bottle, and not first into a bucket or other vessel. The bottle must first be partially filled, and thoroughly rinsed out with the glass-stopper in its place, and must then be emptied and completely filled. The stopper should be tied down or sealed, and a label attached to the bottle, on which all necessary particulars concerning the sample are stated, somewhat as follows:—

SAMPLE OF WATER FOR ANALYSIS.

Taken at........ ....28 Kingsley Terrace, Newcastle-upon-Tyne.
Date when taken............13th February, 1899.
Source........................Well, 20 feet deep.
Means of raising...........Pump.
Sent by.......................Inspector of Nuisances.

It is important that the sample be submitted to the analyst as soon as possible after it is obtained.

In small villages the water for drinking and domestic purposes is generally obtained from shallow wells, and raised either by pump or draw-bucket. In obtaining a sample of such water for analysis, a short description of the well and its surroundings should be added to the above label, as for instance:—

Position of Well............In garden, *or* in roughly paved yard, *or* in an outbuilding adjoining the house.
Top of Well................Covered, below surface of ground; *or* (if a draw-bucket is in use) open, raised a foot or so above surface of surrounding ground. No roof over.
Adjacent ground-surface...Depressed around the well and imperfectly paved, pools of water standing, *or* well-paved.
Drains........................No near drain openings visible, *or* sink 4 feet from well.
Nearest buildings..........House, 10 feet; stable, 30 feet; midden, 30 feet.

In the office-book, where the taking of the sample is recorded, a copy of the label must be inserted.

Again, there are villages and isolated houses where the water taken from rivers is used; and in one hamlet known to the writer, where the underground water was too salt for use, no source of supply was until recently available except rain-tubs, and the field-ditches and ponds, from which the cattle also drank. In cases like the last, report to the Local Authority without an accompanying analyst's certificate would obviously be sufficient.

If by analysis or otherwise any well-water has been proved impure, we should, in the case of a shallow well in a town, advise that it be pumped out, and filled with clay rammed solid. No reason is valid enough to permit such a well, once proved polluted, to be used again, however well cleansed.

In a village, however, where there is no public water-supply better than that of the well, the latter must be restored to purity for continued use, or, what is better still, a new one sunk in an unpolluted spot. But even in the latter event the cause of pollution of the original well, if it is suspected to be a defect in a drain or soakage from a midden, must be searched for and remedied.

The probable causes of pollution in well-water are :—

(1.) Leakage from defective drains.

(2.) Soakage from middens.

(3.) Soakage from surrounding surfaces.

(4.) Decomposable matter fallen into an uncovered well.

Where one of the first three causes exists, indications of it can usually be found on the sides of the well.

Leakage from a faulty drain can be tested by pouring paraffin down a sink, or other inlet to the drain; pumping will soon reveal the fact, if the oil has found its way into the water, and the source of the original pollution will have been discovered without either uncovering or entering the well. Other substances besides paraffin may be used; in fact, anything which possesses scent, or will impart colour, and is non-poisonous. Perhaps whiting or lime-water would do, but if much soil had to be traversed, these substances might be filtered out. Paraffin, however, has the advantage of rendering the polluted water unpalatable, and so preventing its use for a time—a not unimportant advantage, for there are people who would continue the use of polluted water during the interval between discovery of the cause and completion of the remedy, rather than trouble to go far to obtain a purer supply.

If the drain is proved to be the cause of pollution, it must be taken up, and a new and sound one constructed. The ground around the well, and the wall of

the well, must be removed to a depth below the evidences of pollution, the wall rebuilt with new material, and fresh puddle and earth placed outside it. The well must then be pumped dry, the walls below the new upper portion scrubbed, and the sludge at the bottom removed. If the water is afterwards allowed to rise to its usual height, and again pumped out, and this is repeated three or four times, the well will probably be once more fit for use.

If, however, the paraffin-test does not give any clue to the source of pollution, and the walls of the well are found to be foul on one particular side, and that side opposite a midden, it may be fairly concluded that **leakage from the midden** is the cause. Treatment of the well as before, together with removal of the midden and soil under it, *may* restore the well to purity, but the absolute and immediate purification of a midden-polluted well is, it must be confessed, well-nigh impossible because of the greater diffusion of the polluting material. It will usually be safer to dig a new well on a fresh and unpolluted site, and to fill up the spoilt one with earth.

It may be opportune here to remark, that **a polluted well,** the water of which is not used, may be, and often undoubtedly is, a nuisance, especially when it is near a house, or, as is sometimes the case, actually within it. It may be that, when the well was found to be contaminated, it was closed without a search being made for the cause of pollution. If this were a leaky drain, the well is (or was) actually a cesspool receiving the whole or part of the sewage of the house. In case the drain remains unsound, a smoke-test may reveal the perhaps now forgotten existence of the old well, but not if it has been made good since the closure. When careful examination of plumber's work, and severe drain-tests, fail to reveal the causes of ailments which are known to be due to insanitary conditions, some such nuisance as this may well be suspected, and neither expense nor inconvenience should avail to prevent a thorough search being made for it.

The Sanitary Inspector, however, is almost entirely unsupported by law, when insisting on the pursuance of such a course. His legal duty is to declare the cause of nuisance and suggest the remedy[1]: if the former is unknown, the

[1] That it is not necessary for a Sanitary Inspector to suggest a remedy in every case of nuisance has been settled, as the following extract from *The Manchester Guardian*, Jan. 22, 1898, will show:—"A point which has often been raised in connection with prosecutions for the emission of black smoke has just been settled by Mr. Justice Day and Mr. Justice Lawrance, sitting as a Divisional Court, in the appeal of *Millard* v. *Wastall*. The respondent was prosecuted under the Public Health Act of 1875 for having committed a nuisance by permitting black smoke to be discharged from his chimney, but the magistrates dismissed the information on an objection that the notice on which it was founded did not specify the works which had to be carried out in order to remedy the nuisance. The Public Health Act provides that the Local Authority shall serve a person causing a nuisance with a notice requiring him 'to abate the same within a time to be specified in the notice, and to execute such works and do such things as may be necessary for that purpose'. Read loosely, this might seem to intend specifying of the works to be executed, but closer examination shows it not to be so, and the judges had no hesitation

latter is impossible. And he has no power to enforce the tearing up of floors for making speculative search. If ill-health were thought to be occasioned by something giving off a distinct smell, but the cause of which was beyond his ordinary means of discovery, the powers of the Housing of the Working Classes Act, 1890, if this has been adopted in the district, might be used (although, by its title, this statute may be said to apply only to workmen's dwellings), but the gases from the well under consideration are often unperceivable by the sense of smell, and in such a case the Sanitary Authority is utterly powerless to interfere.

It sometimes happens that, because of the frequent sickness of the occupants, a house gets, as it is called, a "bad name", and that the owner will seek the assistance of the Sanitary Inspector, who will then do well to remember this possible cause of offence. Sounding the floors, if of flags, may sometimes indicate a spot for successful examination, but when the flags are supported upon dwarf walls, the operation is useless. It may even be advisable to recommend the entire removal of the floor (usually a basement one), and a thorough examination with pick and shovel.

The contamination of a public water-supply will be considered under three divisions:—

(1.) At the source.

(2.) In the mains.

(3.) In the service-pipes and house.

The term "pure", applied to water used for domestic purposes, must be understood as being used in a qualified sense, as no water is absolutely pure, except that which has undergone careful distillation. Contamination, of course, here means the avoidable addition to the water of deleterious matter.

(1.) **Water may be contaminated at the source** in gathering grounds (when cultivated lands are included in their area) by the admission of flood-waters to the reservoir, especially such as are caused by sudden downpours of rain (as thunder-storms) succeeding periods of comparative dryness. These waters may be highly charged with pollutions from cattle-droppings and from manure. The former may be present even when farm-lands are not included in the contributory portion of the basin, but where animals are allowed to graze on the moors surrounding the reservoir. It should be the duty of an attendant to direct all such floods into the by-passes provided.

Service-reservoirs and filters near towns, especially where manufactures are

in saying that the magistrates had taken a wrong view of the clause. To use the words of Mr. Justice Lawrance, 'it is no more necessary to prescribe works to be done to abate a nuisance of black smoke than it is to abate a nuisance caused by keeping a pig'."—Ed.

extensively carried on, should always be covered, to prevent the access of aërial pollution, and to exclude the sun's rays. Filter-beds may also, if neglected, be a source of pollution, the water having to pass through a layer of decomposing matter.

In towns supplied with river-water, actual sewage from other places may always be present.

Where water is raised from deep bores, and filters are not required, avoidable pollutions at the source are almost entirely absent. Of course, adjacent villages or towns, situate over the same water-bearing strata, and lying beyond the bores in a direction contrary to the flow of the subterranean water, may, through leaky cesspools and the like, contribute impurity. But at the actual bores perhaps no avoidable polluting agencies exist, save improprieties of workmen employed in adits, &c., and, in times of scarcity of water, aiding the supply of the bores by turning into them surface-streams, if there be any near.

(2.) **Few chances of pollution exist in the mains.** Ball-hydrants and defective joints may admit a little dirt when the water is turned off; also during repair, or the affixing of new services, some may enter, but not to a serious extent. In "dead ends" earthy matter and rust are most in evidence; these may be classed as intestinal irritants, and are of course objectionable, but scarcely come under the head of pollutions. They do not add permanent injury to the water, as they readily settle to the bottom of a vessel, leaving the supernatant water free from injurious solutions.

(3.) **In the service-pipes and house, further dangers exist.** Soft water has a solvent action upon lead, and much has been said as to the chances of pollution from lead pipes and lead-lined cisterns, where the water is obtained from lakes and from reservoirs, for which the water is collected from peaty gathering grounds. This was especially the case in Glasgow, when that city was first supplied from Loch Katrine, but little or nothing is now heard of evil consequences arising there from this cause, although the services continue to be made of lead.[1] It is, however, a wise precaution not to use water which has remained long in the services,—over-night, for instance.

It is sometimes dangerous to lay a lead service-pipe unprotected through "made" ground, as it may be acted upon by cinders, lime, or other substances which such ground may contain.

A water-pipe should never be brought up close to a yard gully, for it is

[1] In Glasgow, the water possesses from 1 to 1·10 degree of hardness, that of Manchester 2 degrees; the service-pipes in both cities are of lead. In Dublin, where the water has 2·2 degrees of hardness, the water-services are made of an alloy of lead and 3% of tin. In none of these cities are there any known cases of lead-poisoning caused by the water-supply.

often burst, by frost, under the pavement, near where it emerges from the ground to supply a yard-tap. The ground immediately surrounding a yard-gully, which has a separate top-stone badly fixed upon it, is often saturated with sewage in a very foul state of decomposition. If the pipe which supplies the yard-tap is brought out of the ground close to this gully, it will pass through this filth, so that a crack in it at this point is especially dangerous, and the more so because such a burst, if small, may be allowed to continue, as it causes little or no inconvenience to the occupier of the house.

Disused water-supply pipes are sometimes cut, doubled up at the end, and left buried in the ground. Amongst several such cases known to the writer, was one where the floor of a town cow-byre was in one part always wet. Excavation in the urine-saturated floor revealed a branch water-pipe so treated which was leaking. Filth *must* have been drawn into that pipe when the water was shut off from the main.

Where buildings are being pulled down for street-widening, &c., especially in towns where stop-cocks are not provided on the services in the street, the pipes should be entirely removed from the main.

The Inspector can easily **detect a leakage underground** by pressing his ear against the tap, or by resting one end of a poker, or even a walking-stick, against the pipe or tap, and applying his ear to the other, when the hiss of the escaping water will be heard. Before commencing the test, care must be taken to ascertain that all the taps in the house are closed, not forgetting the ball-taps in cisterns.

To connect a water-closet directly to a water-service pipe is surely a practice only of the past, but relics of this work may still exist. It is not long since a police-station in a large town was found to have a closet in each temporary cell, all so fitted, the water being turned on by means of a tap outside. To open such a tap when the water was "off" would admit an offensive in-draught to the water-pipe.

The water in a cistern which has a W.C. flush-pipe connected to it, cannot be fouled in the same way as that in a service-pipe joined to a W.C. basin, and it would be difficult for the inspector to prove such an arrangement to be a nuisance, unless, as is sometimes the case, an air-pipe be turned over into the cistern from the flush-pipe. It will be seen from fig. 666 that this air-pipe provides a direct aërial communication between the W.C. and the water in the cistern at all times when the flush-pipe is not in use. Such a pipe is provided to ease

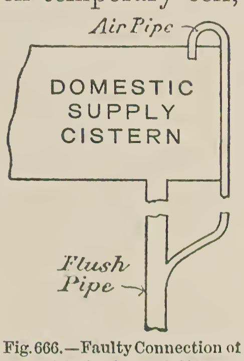


Fig. 666.—Faulty Connection of W.C. Flush-pipe and Cistern.

the pull of the valve on being returned to its seat, and to permit the free descent of the water left in the flush-pipe after the valve is down. It is turned over into the cistern, because, when the first outrush of water meets the resistance of the air in the flush-pipe, some of it might be forced upwards out of the air-pipe, to fall on the floor below, but for this bend, which returns it to the cistern.

In towns which have a constant water-supply, **cisterns for dietetic purposes** are not needed, and where one is found, it is better to advise its total disuse than to suggest a change from a lead cistern to one of another substance. Cisterns in such towns should only be used in connection with hot-water systems, the cold-water taps in kitchens, sculleries, and butlers' pantries being supplied direct from the street mains. Where the supply is intermittent, and storage of drinking-water therefore a necessity, the cistern used for the purpose should not be connected with the circulation-system, but should be a separate cistern, composed of a non-metallic material, and placed in an easily accessible position on the ground-floor.

Although there may be no necessity to use the **cisterns of the circulation-system** for drinking purposes, it is requisite that they be protected from pollution. Their position and surroundings, and the pipes connected with them, must therefore receive the attention of the Inspector. With regard to the first two he may have little power of control, but when a cistern is found beneath the floor of a bedroom, or in a roof-loft opening from an attic bedroom,—both being positions within the writer's experience,—perhaps a notice requiring removal to a more suitable position might be successfully enforced. The cisterns ought to be placed in a room suitably prepared for the purpose, and used for that purpose only. The room should be floored, lighted, plastered, ceiled, ventilated, and be easily accessible. The cistern should be covered with a lid projecting beyond the sides, and slightly raised above the edges of the cistern on small wood blocks placed at intervals on the underside of the cover.

There should be no **pipes connected from the cistern** directly to a W.C., urinal, or housemaid's sink. The overflow-pipe should not be joined to any other, but be carried through the nearest wall so as to discharge in the open air. An overflow-pipe is only in use when a defect occurs in the ball-tap, which permits the water constantly to run. This may not happen for years, and therefore, on account of evaporation, no water-sealed trap can be relied upon for safety when the overflow is connected to another waste-pipe. A copper flap on the outer end of the overflow-pipe is useful to prevent dust being blown through into the cistern.

Another kind of overflow, found mainly in old cisterns, is called a "**standing waste overflow**", and consists of a hollow brass plug fitting into a socket in the bottom of the cistern; to the upper part of the plug is soldered a lead pipe, brought up to the intended water-line, and left open at the top to receive the overflow of water. From the socket downwards is continued a waste-pipe, discharging in some cases near a yard-gully, and in others into soil-pipes and drains. It will be seen that, by grasping the overflow-pipe where it emerges from the water, and giving it a pull upwards, it and the plug at its base may be raised from the socket in the bottom of the cistern, allowing the water to be emptied through it. A standing waste is not an absolute necessity, because the cistern may be nearly emptied through the bath and other taps, as the pipe to the boiler is fixed within about two inches from the bottom. But after scrubbing the cistern, this remaining water, with the dirt, must be mopped out, whilst the standing waste permits the escape of the entire contents.

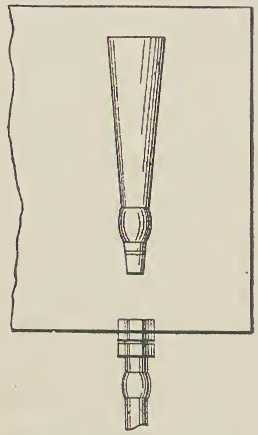


Fig. 667.—Standing Waste in Cistern.

There can be no objection to a standing waste used solely as such, but there is grave reason why it should not also be used as an overflow. To connect such a waste to a drain or soil-pipe is a legal offence,—*i.e.* it constitutes a nuisance under the Public Health Acts,—even where it is not used as an overflow. But even where it is not so connected but discharges into or near a yard-gully, some unnecessary danger exists, when the top is left open in the cistern, because of the possibility of gases, arising from decomposable matter in the gully, passing up the pipe, and thus being brought into contact with the water in the cistern, and perhaps also diffused through the house.

CHAPTER II.

INSPECTION FOR DAMP.

When the bases of house-walls are wet, it may be found that the damp-course is either below, or not high enough above, the surface of the outside ground, or that the builder has "forgotten" to provide one. In the former case, where the ground cannot be permanently lowered, the evil may be mitigated by

running a cement plinth on the outside of the wall from below the damp-course to about a foot above the ground. In the latter instance, a damp-course may be inserted by removing three courses of bricks in lengths of two or three feet at a time. This somewhat expensive and otherwise inconvenient process would perhaps only be resorted to in extremely bad cases, but it has been done.

Absence of (or defective) eaves-spouting may cause the walls to be wet above the damp-course, not only because of the water which runs down the wall, but from the splash of the drip on the pavement, or into the gutter which may have been formed by the fall.

Where basement walls are wet because of the ground outside lying against them, the ground should where possible be removed, and a drained "area" constructed.[1] When this cannot be done, the evil may be lessened by cementing the outside of the wall, or facing it with a wall of tar-concrete 6 inches thick, temporarily removing the soil for the purpose, and backing up the concrete wall as it rises with the returned earth. Even a loose rubble insertion, 18 inches or so thick, between the wall and the earth will have a good effect. When nothing can be done outside, a $4\frac{1}{2}$-inch brick wall may be built inside, leaving a space of $2\frac{1}{2}$ inches between it and the wet wall, such space to be closed at the top and ventilated from the exterior. Even plastering on laths and $1\frac{1}{2}$-inch battens would be an improvement, as the wet surface would be protected from the evaporating influence of the warm room, but battens in contact with a damp wall are liable to rot.

Where brick walls above ground are damp from driving rain, it is generally because they are too thin, or the bricks are not well burnt and consequently inordinately porous, or the joints have not been well filled with mortar. To lath and plaster the wall inside on battens, and repoint it outside, would effectually remove the unsightliness of stains, and perhaps remove the danger to health, but complete dryness can only be obtained by thorough painting outside, or covering the exterior with stucco and then painting it, or by slating. Damp walls are sometimes covered with matched or grooved-and-tongued boards on battens, but for several obvious reasons this method cannot be recommended.

The inspector should fearlessly report house-walls which are actually wet, but should hesitate where damp stains only are apparent, and in such a case only do so after the Medical Officer of Health has declared them to be so bad as to endanger health.

The upper parts of house-walls may be wet from defective eaves or eaves-

[1] See fig. 38, page 66, vol. i.—Ed.

gutters, or because of the saturated state of the brickwork projecting above the roof, such as parapet walls and chimney-stacks. The latter fault is apparent mainly in attic rooms formed in the roof. In the former case, a fault in the coping, or the lead gutter behind it, may be discovered. In the latter, the only cure would be to take the stack down to near the roof slates, lay on a damp course of lead, and re-erect the chimneys.

Wet ceilings in upper rooms are of course caused by defects in the roof covering, and in searching for these it must be remembered that the fault may not be immediately over the damp spot, as rain will often trickle down a rafter some distance from the broken slate, tile, defective flashing or secret gutter, before it drops on to the ceiling below.

When "**lead-flats**" have much "fall", the sheets of lead, by unequal expansion and contraction, may "creep" downwards and expose the drips, whilst in lead-covered roofs which have a decided slope, the sheets may actually slip and expose the joint at the ridge. It is unnecessary to say that defects in the lead itself, as well as bad workmanship displayed by insufficient overlap at drips and flashings, account for some leaky roofs. One house within the writer's experience, the flat roof of which was surrounded with parapet walls, was a perfect shower-bath during severe frosts with snow. The underside of the snow was melted by the heat of the house, and the resulting water, unable to escape through the frozen gutter-outlets, formed a pond on the roof, which rose above the rolls and poured into the rooms beneath.

When the inspector notices that **the boards of ground-floors** are excessively curved, the edges being raised in sharp ridges, he will suspect dampness or even water underneath. He can test this by boring three or four holes through the floor-boards with a large gimlet (having first gained the consent of the owner or occupier), and passing a thin iron rod—a stair-rod will do if it is long enough—down into the soil beneath. The holes may afterwards be stopped with wood plugs. If he is not satisfied with the result of this trial, he should get underneath the floor if the space permit, and make a thorough examination. If there are no means of access already provided, he can, with the permission of the occupier, cut through three or four boards between a pair of joists. The pieces of floor-board so removed may be replaced after nailing a cleat or fillet to the side of each of the exposed joists. The only tools needed for this operation are a gimlet and a keyhole saw. The nails and pieces of wood for cleats are usually to be found upon the premises.

Flags or bricks laid directly upon the ground are generally damp, the dampness being more apparent under an impervious covering, such as oil-cloth or

linoleum, than upon floors which are uncovered. A thick layer of sand or ashes upon a bed of broken bricks underneath the flags or tiles will often remedy the evil, and if the floor is above the surface of the ground outside, this foundation may be further improved by embedding in it air-drains of agricultural pipes, open at each end, behind a perforated brick in the outer wall of the house. Flags may also be laid upon dwarf walls covered with slate, and ventilation provided underneath.

Where floors are below the outside surface, air may be admitted to the underside by forming a flue in the thickness of the outer wall, opening at the bottom under the floor, and at the top into the outer air, as shown in fig. 668.

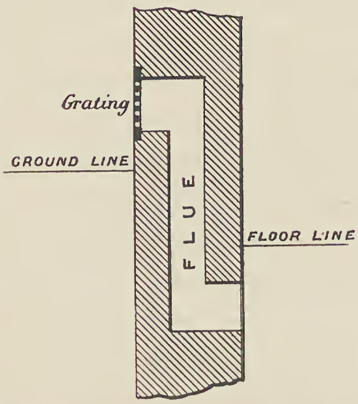


Fig. 668.—Air-flue for Ventilating Floor below Ground.

Dry-rot under wood floors is favoured by dampness and want of ventilation, the provision of ample ventilation alone often removing the dampness and killing the fungus when the latter is in the earlier stages of its growth. A musty, mushroomy smell will arrest the attention of the inspector where this pest is present, and on raising the edges of the carpet, fine filaments of the plant may sometimes be seen on the top of the floor-boards near the skirting. In neglected and bad cases, large fungi may appear at the margins of the floor when the room has been closed even for a few days; quite a cart-load has been removed from beneath a floor so affected. When the evil has reached a bad stage, nothing but the entire removal of the floor, washing the bases of the walls, and saturating the ground-surface with hot lime, will eradicate it.

Dry-rot is probably more to be feared when the house is built upon "made" ground, which often contains vegetable or even stable refuse. Its presence, therefore, should lead to the suspicion of this being the case, and the further precaution should be taken of covering with cement concrete the whole surface of the ground, after liming and before laying the new floor. There are, of course, strong reasons why the surface of the ground under houses should be covered with cement concrete even where "made" ground is not present, but this has already been dealt with elsewhere in this book.

CHAPTER III.

INSPECTION OF SANITARY FITTINGS, &c.

It may appear at first sight paradoxical to say that the better the class of house, the greater the possibility of sanitary defect, but at a second glance we remember that the number and variety of conveniences provided in the houses of the wealthy are absent in the workman's cottage or small town dwelling. It may be imagined that the sanitary arrangements of the rich man's house are so good in quality and design as to be almost beyond the possibility of getting out of order. This may often be the case, but the inspector must not take it for granted, as the craving for cheap work and material is not confined to the poor. The sanitary fittings of the labourer's house are usually out-of-doors, but those of large houses are mainly within, and consequently the more dangerous when defective. Good and bad forms of sanitary fittings have been described in a previous Section, and we will here only show the method followed by the Sanitary Inspector whilst inspecting for legally-abatable nuisances.

Where **a "pan" water-closet** with boxed-in seat is found, the basin and container must be looked at to ascertain if they are in a foul condition. The latter generally is so. It may easily be examined by separating the copper-wire chain which connects the handle to the cistern-valve, as then the pan may be depressed without bringing down the water-flush. The D-trap may be filthy, but its interior cannot be seen.[1] The top of the container has a strengthening rib around the outer margin; offensive liquid spilt upon it is therefore retained, as when bedroom slops are carelessly thrown down the closet. The underside of the seat and the floor may also be saturated with the liquid.

Brick walls under boxed seats are rarely covered with plaster; this omission may permit smells during the use of the closet to pass through defective joints into an adjoining room, when the plastering of that apartment is not continued down to the floor behind the skirting. A defect in the ceiling under the closet, if the latter be on an upper floor, will allow the descent of smell into the room beneath. A few grains of sulphur, or even a little brown paper, burnt on a plate under the seat with the lid down, will reveal these defects.

The flush of the W.C. should be ample, without being wasteful, but it is somewhat doubtful whether the Public Health Act, 1875, gives Local

[1] It is here assumed that although some Courts of Summary Jurisdiction have made orders supporting notices for the removal of pan water-closets simply because they were such, no legal powers exist to enforce their abolition, unless it can be proved that they are in a foul condition.

should be trapped, and discharge near gullies outside. When they are in basement kitchens, partially underground, the wastes are often joined directly to the drains; these must be disconnected by sinking a small "area" outside, in which a trapped gully may be fixed, and the waste-pipe caused to discharge near it.[1]

The inspector should always **find out whether waste-pipes are trapped or not;** this he can do by holding his wetted finger or a lighted match across the outgo in the fitting, when, if a draught be observed, he may safely conclude that there is no trap. Another way is to pour strong-smelling liquid, such as sanitas, carbolic acid, or paraffin, upon or near the pipe at the point of discharge; or burn a little brown paper at the same place. The scent or smoke will often be drawn up through an untrapped waste-pipe, and be observed at the fitting.

Lead safe-trays are not often now fixed under baths, but when found the point of discharge of the waste-pipe must be discovered. It is very essential for this to be in the open air (protected if necessary with a copper flap), as trapping it is of little use, seeing that water may seldom if ever pass through it. It is highly improper to join the safe-waste to the bath-waste, for in case the trap in the latter becomes obstructed, flooding of the safe will occur.

CHAPTER IV.

DRAINS.

Drains are tested with either scent, smoke, or water. In the first, strong-smelling and volatile liquids are poured into the drains, defects in which may be revealed by the after-occurrence of the scent in rooms or cellars. Sanitas, carbolic acid, or paraffin will answer the purpose, but peppermint and other expensive scents are often used. The inspector, however, usually uses either smoke or water in making his tests.

The smoke-test is applied by forcing into the drain a pungent smoke, either from a rocket-case filled with a pyrotechnical compound, or a "smoke-machine" burning cotton waste.

It was once said to the writer, by an author of books on sanitation, that the smoke-test is useless, and not worthy the name of test. This is a very unfair statement, and carries with it no conviction of having been made from

[1] See fig. 355, page 455, vol. i.; an alternative arrangement is shown in fig. 356, page 456, vol. i.—Ed.

practical day-by-day and all-round experience. If properly applied, it will discover nine faulty drains out of ten, and to the experienced inspector will give some suspicion of the remaining one, which, at a subsequent trial, under different atmospheric conditions, may be resolved into proof. The worst that can be said against the smoke-test is that, in a list of (say) 1000 drains, 995 of which are sound, it may discover the five faulty ones, but leave the inspector in doubt about the others, and the inspector must enter these in his book as "in good order", when he has only the negative fact of "no results" to support his record.

The smoke-rocket is a very useful article, as three or four of them can with ease be carried about by the inspector on his ordinary rounds, for application as a sort of "first aid". It affords a simple test, and often discovers a fault, thus rendering more elaborate efforts unnecessary.

The rocket is usually applied at an emptied gully-trap or other drain-inlet, and burns for about five minutes. When one is exhausted a second may follow, but here a word of warning is necessary. If the drain at the exposed part is full of dense smoke when the first rocket or smoke-case is withdrawn, the second must not be applied until the smoke has cleared away, or an explosion may occur—a slight one, perhaps, but sufficient to injure the hand which holds the second rocket, or the head which may be over the sink. In the old-fashioned "cesspool" gullies, the rocket can, when well alight, be passed into the water and pushed up to the outlet without being extinguished; it is well to know this, as the emptying of gullies is not always a pleasant job. It may be necessary to flatten the mouth of the rocket under the inspector's heel, in order that it may enter the drain more easily.

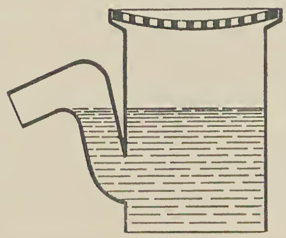


Fig. 670.—Section of Old-fashioned "Cesspool" Gully.

It has often occurred to the writer that the plunging of a fiery rocket into an earthenware gully, drain-pipe, or W.C.-trap, would be likely to cause fracture, but he has not seen any instance of this. Having regard to this possibility, however, perhaps the best way of using the rocket is to inclose it in a metallic sheath or box, to one end of which is attached a brass pipe, long enough to allow a rubber tube to be slipped on the end without being in danger from the heat. The free end of this tube (see fig. 671) can be passed through the

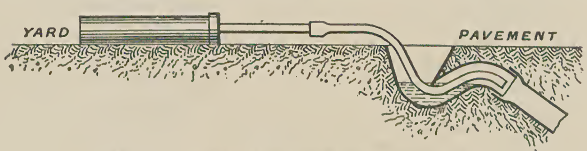


Fig. 671.—Sheath and Tubes for Smoke-rocket.

gully or W.C.-trap, first removing the water with a ladle or syringe, and replacing it when all is in position. It may not even be necessary to remove the water, as a sharp blast from the inspector's mouth, applied to the rocket-end of the rubber tube before attaching the rocket-case, will easily remove the water which enters and lodges in the bent part of the tube as it is passed through the trap. Another sheath, made by the writer for application to gullies, is shown in fig. 672, and consists of a case similar to the last, but the projecting tube is longer and bent horseshoe-like, no rubber being used. This instrument, with the lighted rocket in it, is simply passed down through the water in the gully, and hooked up under the trap, so that it is not necessary for the inspector to touch the sewage. It is tied up in this position—from an "eye" brazed on to its side—to a spout or water-tap. The rocket will blow out all the water in the bend.

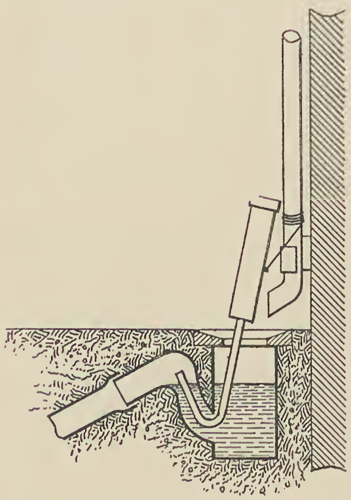


Fig. 672.—Sheath with Bent Brass Tube for Smoke-rocket.

Smoke-machines are of three forms, each forcing air into the drain through burning cotton waste. One has a fan-blast, worked by turning a handle which drives the fan; another contains a leather bellows fixed in a box by the side of the waste-container, and worked by moving an upright handle to and fro. Both these are very useful and powerful machines, but they are too cumbersome for the ordinary work of the inspector. The best compromise is the third form, which consists of a water-seal bellows; and among the best of these is that shown in fig. 673, and made by a Newcastle firm in accordance with the writer's suggestions. This apparatus is not patented, and the cost of one will probably not exceed £2, whilst as much as £5 may be asked for patented, but possibly not superior appliances.

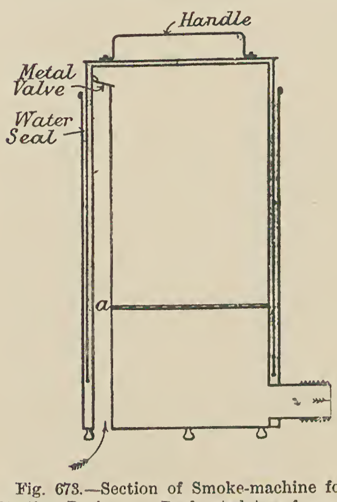


Fig. 673.—Section of Smoke-machine for Testing Drains. *a*, Perforated tray for cotton waste.

In applying the smoke-test, those parts of a drainage-system, the ends or heads of which are closed by traps, such as branches and unventilated soil-pipes, may, if sound, not be permeated with smoke. It is necessary, therefore, before commencing, to draw all the traps, W.C. traps included, and to restore the seal immediately on

the appearance of smoke. This will not only ensure every part being brought under the full influence of the test, but will tend to remove doubts that might otherwise arise as to the efficiency of the examination. Where possible, the vent-shafts must be closed as soon as the smoke is seen to issue.

Some drains have an outlet-shaft on the soil-pipe, but are not "intercepted" from the sewer. Even in this case, if the outlet-shaft is closed after the smoke has begun to issue from it, the test will be good, although the lower end of the drain is open to the sewer. If no smoke escapes at the shaft, or at any of the unsealed traps,—a sign that the draught is towards the sewer,—then the test is not reliable, and must be repeated under different atmospheric conditions.

In drains which *have* intercepting traps, and where the vent-shafts can be stopped, the smoke-test will, if continued a reasonable time, invariably discover a fault if it exist. Where cement or asphalt covers the yard, small holes may, with the permission of the occupier, be "picked" through it over the supposed line of drain. This, however, need only be done if no result is found without it, and if the experienced inspector is led from other observations still to suspect the soundness of the drain. The holes must, of course, be afterwards filled with cement.

If **the light of a taper or candle** be held over a hole or crevice in pavement or wall, or passed along a skirting, whilst a smoke-machine of the kind already shown is being worked, the flame will pulsate with every beat of the machine if the drain is not sound, and if there is ever so small a connection through the ground between the hole or fissure and the faulty part of the drain. This test is as unerring as it is delicate, and often reveals a defect when even the smoke refuses to traverse the passage, seeing that it does not depend upon the transmission of anything, either scent or smoke, from the machine to the flame, but upon a wave motion pneumatically imparted to the intervening air.

The water-test consists in filling the drain with water to the top of the highest gully. This is a *positive* test, whereas smoke, as already stated, gives in many cases only *negative* results. It is, in some cases, *too* positive, because it will *make* a nuisance where none existed before, as in a well-made clay-jointed drain.[1] The water-test can only be applied to old drains if access-chambers are provided upon them. Inspectors are not empowered to dig down to and sever drains, in order to plug them for the water-test, and although drains *ought* to stand chokage without emission of sewage through the joints, the inspector has no right in his search for nuisances to blow out by his test the joints of a clay-jointed drain that has not been choked, and which are efficient whilst the drain remains

[1] This remark has, of course, no reference to drains of cast-iron.

clear. If therefore, where access can be had, he applies the water-test to an old drain, without the consent of the owner, he risks rendering himself or his authority liable to an action for damage, as it may be alleged that the drain now leaking was previously tight, and not in such a state as to be a nuisance, which allegation he may be powerless to refute. The smoke-test, however, is applicable to all drains at all times, and, if it be properly applied, the fault which it will not find, even with the ends of sewer and vent-shaft open, must be very minute.

All new drains ought to be submitted to the water-test, and in this work, and this only, ought it to be used, unless by the express desire of an owner anxious to have drains of the very best kind. It is customary, however, because of obvious difficulties, only to apply the test to that part of the drain which is within the private premises, and not to that in the public street between the premises and the sewer. The usual method is to plug the drain from the interior of the access-chamber, stop all the lower gullies, and fill the drain to the top of the highest one. Each drain entering the chamber is similarly treated. It is well to allow the water just to appear in the lower gullies before stopping them, otherwise the branch-drains, to which they are attached, will be air-locked. This, of course, will not matter if the drain is sound, but if it is not, time may be lost in waiting until the air escapes from, and the water reaches, the defective point.

The plugs used in stopping drains, before the application of the water-test, have been described and illustrated in Section VII., Vol. I., and nothing need here be added on the subject. It may, however, be mentioned that gullies may be stopped at the neck by passing into them a strongly-made india-rubber bladder with tube attached, through which the bladder may be inflated with a small force-pump, such as is used for inflating bicycle tyres. When all is ready, the drain is filled with water.

The entire drain must be left exposed, until this test has proved it to be sound, but **each pipe should be supported on concrete** in the middle of its length to prevent its being disturbed if trodden upon, and during the filling of the trench, as a sound drain may be injured during the latter operation if this precaution be neglected. After the test, the remaining portion of the underside of the drain—beneath the sockets—should likewise be concreted. The expense of this concrete is very small, and, in addition to holding the tube steady, it ensures proper support at the part most needing it. It is of little consequence how the upper part of a drain is covered compared with its nether side; when *that* is solid, the arch formed by the upper side of the pipe is well supported to bear the weight of the superincumbent earth.

Concrete is not applied to the exterior of a drain to make, as it were, doubly sure of the soundness of the joints, but to ensure the stability of a drain perfect in itself. If the joints are not sound, concrete cannot be depended upon to make them so; and if they are, they require no additional perfection from that material. The drain may, of course, be entirely covered with concrete after the water-test, if so desired, but that on the upper part is of far less use than that underneath, adds somewhat to the expense, and may be an inconvenience when alterations to the drain are required.

It will be observed that **the access-chamber** itself was not included in the foregoing test, but as it forms a part of the drain, and will probably be filled with sewage if the interceptor-trap becomes choked, there is quite as much reason why it should be tried as severely as the drain itself. But where, as is often the case, the top of it is below that of the highest gully, it could only be included in a second test. Again, in order to embrace it in the trial, the drain must be plugged on the sewer side of it, for which purpose three or four pipes would have to be left out of the drain between it and the sewer.[1] The drain may be plugged from within the sewer if the latter is large enough to allow of a man passing up it, in which case the access-chamber could be tested together with the street portion of the drain. Because of these difficulties, therefore, although the chamber ought to and can be tested, it is usual to insist and rely upon perfection of workmanship.

Access-chambers as usually made,—*i.e.* with open channels,—are liable to be filthy if not made in the best form, whilst the retention of a large body of inert air—which they make unavoidable—is contrary to all the canons of successful drain-ventilation. Again, their walls are liable to be not water-tight, in which case, if a chokage takes place in a trap beyond or within them, they become leaky cesspools, hiding, *because* they leak, for a long time, the fact of the obstruction having taken place. In the meantime, the ground outside them becomes saturated with sewage, which no subsequent clearance of the drain will remove. It is better therefore for the drain, in its passage through the access-chamber, to be inclosed or continuous as an air-tight tube and fitted with screw-down removable covers. An access-chamber should be intended merely for access, and not be liable, through the choking of an intercepting trap, to become part of a drain,—in fact a cesspool. Even at the best an access-chamber (because of its great capacity) is incapable of perfect ventilation through a 4-inch pipe. Where drains in small systems are properly

[1] The trap itself may be plugged from the chamber, but the plug must be of such a form as to admit of being released from the surface of the ground, when the chamber is full of water.—Ed.

made, and therefore unchokable with ordinary use, access-chambers are unnecessary. A 4-inch pipe brought up from the intercepting trap to the surface of the yard pavement provides sufficient means for releasing the chokage of the trap if it occur. From this pipe (fig. 673 A), which is closed at the top with a cast-iron disc loosely fitted into the uppermost pipe socket, is taken the branch for the inlet ventilation shaft, and it may also receive, one below another, the several branch drains on the premises.

Some people appear to think that the word **"ventilation" in connection with drains** means relief from pressure, and that pressure of a distinct kind exists even in well-ventilated sewers, and therefore in the drains connected with them. We often find a shaft on the soil-pipe relied upon for such "ventilation", no intercepting trap or air-inlet being provided. Such shafts are *sewer*-ventilators only, and bring increased danger to the occupiers of houses possessing them. The general principles and methods of drain-ventilation have been described in Section VII., Vol. I., and only a few remarks need now be made. The motion of air in drains is very sluggish, and all bends make ventilation more difficult. The inspector will therefore discountenance the use of all unnecessary turns, advising that all needful ones be as long and slow as possible, prohibiting those at right angles, and utterly condemning such arrangements and positions as involve two or three such angles following each other (fig. 674).

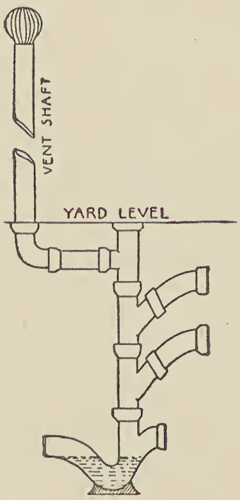


Fig. 673 A.—Pipe-shaft from Trap.

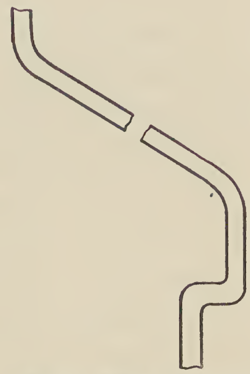


Fig. 674.—Faulty Outlet-shaft for Drain-ventilation.

CHAPTER V.

INSPECTION FOR THE VENTILATION OF ROOMS.

The ventilation of rooms in ordinary dwelling-houses is usually sufficiently provided for by the door, windows, and fireplace. Efficient ventilation consists in providing inlets and outlets for air, and includes the complete control of both.

For admitting the outer air, no better means exist than that obtained by slightly lowering the top sash of a window; this, if opened only an inch clear of

the upper bead, will expose a total space at that part—in a three-feet-wide window—of 36 square inches, and an equal amount at the meeting rails. Here we have a perfect ventilator possessing both inlet and outlet openings. The inlet at the meeting rails just above one's head, and with an upward inclination; the outlet near the ceiling, to which the heated air ascends.[1] This method, however, seems to be too simple and commonplace for the novelty-loving popular mind, which is more satisfied with some jimcrack invention. A less satisfactory method consists in providing a loose piece of wood to be put under the lower sash; this gives one opening only in the window, and that at the meeting rails. A better arrangement is to make the lower sash with a deeper bottom rail, and to increase the height of the lowest bead of the sash-frame to correspond; the lower sash can be raised (say) 2 in. so as to admit air at the meeting rails without allowing any to enter at the bottom of the window.

It is claimed as one advantage derived from **open fireplaces,** that when in use they aid ventilation. Of course this is true, but the floor-level is not the proper position for an extract-ventilator, unless warm air is supplied from a higher point. How often, in small rooms especially, do we find intolerable draughts of cold air rushing across the floor from door to fire, which no amount of "listing" or curtain arrangement will adequately prevent. This is unscientific ventilation, almost useless (being confined to a part where it is least required), and likely to be injurious to health. The best way to extract overheated air from a room is through a special air-flue, formed in the chimney-breast at the side of the smoke-flue, opening into the room near the ceiling through an ornamental grating, and at its upper end into the roof-space above the topmost ceiling. This, however, can only be arranged for during the construction of the house. In houses already built, a flap-valve, opening only inwards, can be fixed in the chimney-breast, so as to admit the vitiated air into the smoke-flue. This will not only allow foul air to escape, but, by partially satisfying the voracious chimney, will lessen the intake at the floor-level, and consequently the before-named objectionable draughts. Against the use of this valve are the inevitable discoloration of the wall-paper near it, and the clicking sound of its flaps.

Another method of decreasing the violent extraction of air from the lower part of the room, which is capable of application after the house is built, is to supply the fire and chimney with air from outside the house; or, in a lower room, from beneath the ground-floor. This can be accomplished by fixing a tube at the side of the chimney-breast, opening into the chimney both above and below

[1] When a fire is burning in the room, both openings will usually admit air; this also will frequently be the case even without a fire in the room.—Ed.

the fire, as shown in fig. 675. This tube, fitted with valves, gives much control over the air-currents: with both valves closed the chimney will draw air only from the room; with the lower one only open, the room-draught will be lessened, and the fire burn as rapidly as before; and, with the upper one only open, the room-draught will be eased, and consumption of fuel economized. Other possible modifications will also be apparent to the reader, such as opening both, or partially opening one or other of the valves. With the ground-floor arrangement an additional advantage is gained by increasing the ventilation under the floor.

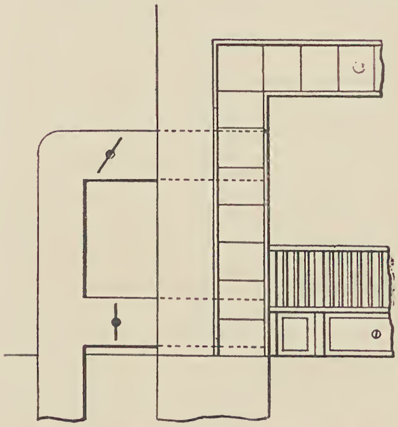


Fig. 675.—Elevation of Draught-regulator for Fireplace.

Where none of these things can be done, and it is desired to decrease the discomfort caused by draughts across the floor of the room, it is better freely to admit the air near the top of the wall next the outer passage, than to try to stop its entry by packing the door. It will then be warmed by passing through the upper air on its course to the fire, thus diffusing the heat through the room, and at the same time diluting and assisting to remove that portion of the air which is the most impure. Openings made in the wall, say above the door, for this purpose, could be fitted with controllable valves, made ornamental, or masked with a picture.

In sleeping-rooms, where fires are seldom lighted, the air during occupation is quieter than that in living rooms, the door and often also the windows being closed. The air-current is of course not so violent when there is no fire, and therefore little or no inconvenience is felt as it passes to the chimney from under the door. The chances, however, are often against the air taking this direction, as many people never have a fire in the bedroom, in which case the flues become cold, and in the winter, damp; under these conditions an upward air-current in them is not to be relied upon. An occasional fire in the bedroom grate during the winter for the purpose of warming the flues, is very helpful in maintaining healthful conditions of gentle ventilation. In the summer, the upper window-sash ought rarely if ever to be quite closed, perhaps only in damp or boisterous weather.

Small rooms in which there are no fireplaces are sometimes found, and where the window and door are at the same end. These are not suitable for bedrooms, as the ventilation of the back portion can never be efficient. It can, however, be improved if the floor-joists run from front to back, by using the

space between two of them as an air-tube, with a grating in the outer wall at one end, and a Tobin tube at the inner end, as shown in fig. 676. If this cannot be done under the floor, it may be accomplished above the ceiling, between the plaster and the upper floor-boards, or an air-duct may be constructed under the ceiling in the room itself; in these cases Tobin tubes will not be required. One or more openings may be made into this duct to permit the fresh air to descend into the room, or heated air to escape. It will be better, where practicable, to have both these arrangements,—viz., one under the floor and one above the ceiling. These ducts doubtless leave the direction of the air through them very much to chance; under some conditions they may be inlets and under others outlets, but movement in any direction is better than stagnation.

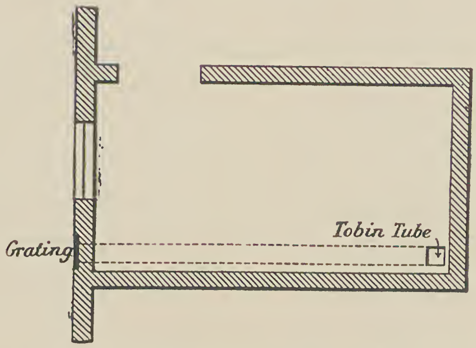


Fig. 676.—Plan of small Bedroom, showing Method of improving Ventilation.

In common lodging-houses, rooms without chimney-flues should never be used for bedrooms, and the Inspector should see that fireplaces, where they exist, are not closed, for the keepers will often board them up when lodgers complain of draught, rather than provide screens for the beds nearest to them. In a bedroom occupied to the extent of one person to every 300 cu. ft. of free air-space, it is difficult to obtain sufficient ventilation without causing intolerable draughts. The air of such a room is often sickening to a person who enters it from out-of-doors, soon after it has been used. But possibly for economic reasons a higher minimum of space could not have been successfully insisted upon, even had it been suggested by the Local Government Board. Seeing, however, that, to conserve heat, the poorer classes not only crowd into rooms, but make matters worse by closing door and windows, it would perhaps have been better had some such tubular ventilators as have already been mentioned, been provided for in the Model By-laws (which most towns copy), especially with respect to common lodging-houses.

A slight digression may here be allowed, to remind the Inspector that **floor-space** is of first importance in measuring up a sleeping-room. The Local Government Board, in their by-laws, are silent on this point, hence a mistake may be made if the total capacity of a high room is divided by the 300 cubic feet of space they suggest. In a common lodging-house, for instance, a bed for a single person (6 feet by 3 feet), with room for approach, cannot well occupy

less floor-space than 36 square feet (8 feet by $4\frac{1}{2}$ feet); therefore in a room 12 feet high, 432 cubic feet would have to be allotted to each person in order to give him the necessary floor-space. Again, a room 24 feet long by 16 feet wide and 12 feet high has a cubic capacity of 4608 feet; if this sum be divided by 310 (the extra 10 feet being allowed for the cubic space occupied by the bed), it will appear to be suitable for 15 lodgers, whereas the floor-space only admits of 10 beds.

In the older parts of most great towns are to be found streets of large and lofty houses, once the residences of the wealthy, but now let out in tenements. The stairway, which is the common means of access to the several rooms, is also the principal channel for ventilation. For this purpose a louvred opening in the roof above the staircase, and another over the front door, will be found useful. The one in the roof must be dormer-shaped, with louvred laths in front, or a small turret with laths on all sides.

It is often undesirable in a direct manner to supply copiously the **smoke-and-soot laden air** of some towns.[1] In these cases, therefore, it is essential that openings for inlet-ventilation be small, numerous, and distributed about the room, and that all of them, so far as practicable, be inclosed in a muslin-covered wire cage, the area of the muslin surface being many times greater than that of the opening. Some ventilators have muslin or cotton-wool smut-screens in their interior, but these not only seriously reduce the air-passage, but are quickly choked, and—being hidden—their condition is not observed. Others provide that the air shall first impinge upon water, on the frequent renewal of which their efficiency as dirt-removers depends. Both these arrangements are sure to be neglected, and the cage method may also be, but with less likelihood, as the screen in this case is always in sight, and no effort of memory is demanded.

The size of the openings necessary to admit the required amount of air cannot, of course, be scientifically fixed, as the volume of air passing through them is dependent upon many atmospheric conditions. They should, however, be as large as convenient, and possess means of controlling their area. As some guide, it is usual to regard the velocity of air passing through an unobstructed opening a foot square as five feet a second, or 18,000 cubic feet an hour, and the amount of air necessary to keep the permissible impurity as low as ·2 volumes of CO_2 per 1000 volumes of air, as 3000 cubic feet per hour per person.[2] In the

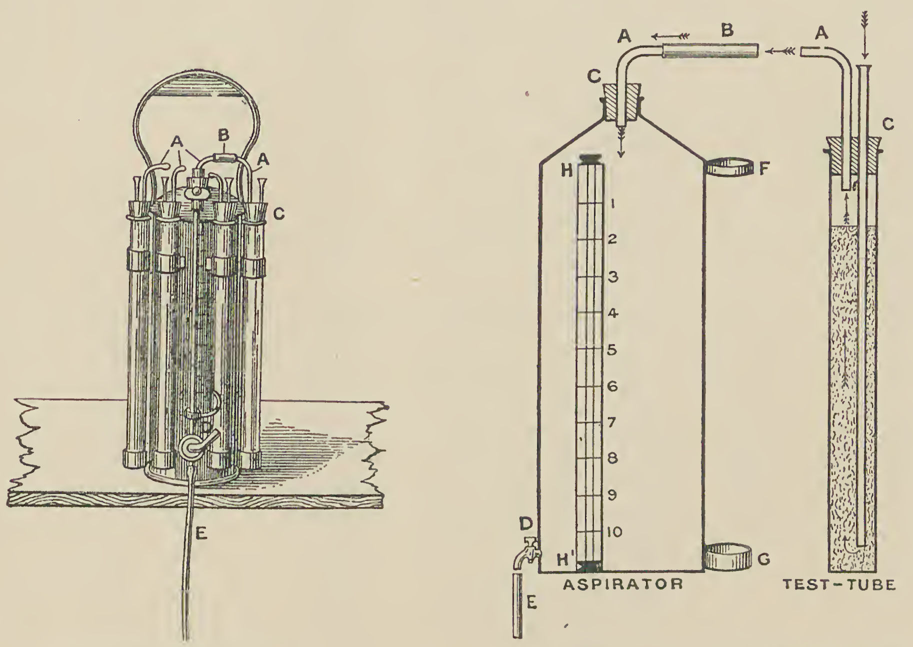
[1] Dressmakers' workrooms, where expensive and delicately-coloured fabrics are being used, are places more especially in the writer's mind, but the remark applies also to ordinary houses, as the admittance of dirty air is not only injurious but adds seriously to the labour of keeping the house clean.

[2] Three ordinary gas-burners are usually counted as equal to one person. This is under the mark, as it is estimated that one medium-sized gas-jet vitiates as much air as five or six persons.

calculation it will not be necessary to provide that the whole of this amount must pass through openings specially provided, because the door and windows will take their share of the work. Therefore every case must be judged upon its merits.

The actual amount of air coming into a room from all sources can only be correctly ascertained by finding the area of the outlets, and the velocity with which the air is passing through them. The latter can be obtained with an anemometer.

The Inspector's nose is the only instrument required in the first place to detect insufficient ventilation, but **a handy chemical "ventilation-indicator"** has



The Apparatus (without case). Enlarged Sections of Aspirator and Single Test-tube.

Fig. 677.—Dr. Scurfield's Ventilation-indicator.

AA, metal tubes; B, rubber tubing; CC, rubber stoppers; D, tap for letting off water; E, tubing slipped over tap to increase suction power: F, ring for test-tube; G, socket for test-tube; HH, gauge.

recently been invented by Dr. Scurfield, the Medical Officer of Health for Sheffield, which will undoubtedly prove very useful in detecting the approximate amount of CO_2 in the air of rooms. In the doctor's own words, "The object of the apparatus is to furnish a reliable comparison between the percentage of carbonic acid in the air of a room and the air outside. The apparatus, when ready for use, consists of an aspirator filled with water and supplied with a gauge, surrounded by a number of tubes, all containing exactly the same quantity of the same pink solution of baryta and phenolphthalein. Each tube

can be in turn connected with the aspirator, so that as the water is run off from the aspirator, an equivalent amount of air bubbles through the pink solution in the tube, which loses its colour quickly or slowly, according as there is much or little carbonic acid in the air. The apparatus is carried in a case, which is used for catching the water and refilling the aspirator when necessary.

"When the decoloration is complete, the tap is turned off, and the amount of air that has been necessary to effect the decoloration is shown by the amount of water that has been run off from the aspirator. For example:—One tube is decolorized in the outside air, and it is found that 1·8 cans of air are necessary to do this. A second tube is decolorized in the room under observation, and it is found that 1·2 cans of air are necessary to do this. Then—the amount of carbonic acid in the air of the room is to the amount in the outside air as 1·8 is to 1·2, or, in other words, the air of the room contains half as much again carbonic acid as the outside air."

CHAPTER VI.

REPORTS.

The ordinary periodical report of the Inspector may be headed as follows:—

"Report of the Sanitary Inspector (or, Inspector of Nuisances) to the Sanitary Committee of the District (or other) Council of ———, for the fortnight ending ———".

Or simply, "Report of the Sanitary Inspector for the fortnight ending ———".

It will be convenient to divide the report itself into sections, thus: "Tabular Report of the Work of the Sanitary Inspector", "Common Lodging-houses", "Workshops", "Food and Drugs", "Canal Boats", &c., followed by "Nuisances"—under which heading may be described any special nuisance about which instruction is desired,—and then by "Legal Proceedings"—in which section is reported cases which the Inspector may have had before the magistrates, and the results.

It is customary for Inspectors to serve **notices requiring abatement of ordinary nuisances,** and compliance with the provisions of various sanitary statutes, by-laws, and regulations, as soon as such nuisances and non-compliances come to their knowledge. If these notices are not obeyed, a second notice, issued

by order of the Sanitary Authority, must be served before legal proceedings can be taken, except perhaps in the case of by-laws and regulations where the service of notices is not provided for.

These two kinds of notices may be classed as "Informal" and "Statutory". When they fail, the fact must be reported to the Authority, in order that the next step may be taken, but it will be unnecessary in the report to describe in full detail the matters to which they refer. Three headings will be found useful:—

(1.) "Informal nuisance notices not complied with."

(2.) "Statutory notices not complied with."

(3.) "Tenement by-law notices not complied with."

The following simple table will be applicable to all the headings:—

Premises.	Complaint.	Notice served to.

Under the two first heads—"Informal" and "Statutory"—may be placed all notices which deal with insanitary conditions, as well as those served under Section 94, Public Health Act, 1875; as, for instance, notices under Sections 23, 36, and so on.

The last heading—"Tenement"—refers to by-laws which may be made under Section 91, Public Health Act, 1875. It is not necessary to report these notices twice, as Informal and Statutory respectively, because by-laws rarely provide for the service of any notice at all. Therefore, an order to summon may follow the report of non-compliance with the Inspector's notice. In the few cases, however, where notices are legally necessary, the order to serve the Authority's notice will be given instead of the order to summon; after which the notice may be further reported under the heading "Statutory notices not complied with". The heading may, of course, be varied so as to apply to other by-laws, or be made general; as, "By-law notices not complied with".

It is a good plan for the Inspector to write only upon one page of his report book, leaving the opposite one for the Authority's instructions.

So far as notices are concerned, we have only provided in the Inspector's report for those about which he requires instruction, and not for those which have been complied with; but these, and all notices served, together with their results, must be reported at every regular meeting, in a book specially prepared for the purpose, and called the "Notice Journal", or "Notice Register".

It sometimes happens that a matter of importance occurs between the end of the regular period up to which the ordinary report is dated, and the date of the meeting at which it is read. Such things should form the subject of an addi-

tional report headed, "Special (or supplementary) Report of the Inspector of Nuisances, —— day of ——".

All reports should be signed at the bottom, not with the formula, "I am, gentlemen", &c., but simply with the Inspector's name.

As a matter of courtesy, nuisances which occur upon premises or works which are under the control of another department of the same Authority, should be brought under the notice of the responsible officers, and not at first reported to the Authority, or reported with the addition of such words as, "This is receiving attention from the ——". Of course these matters must eventually be reported, if the department interested does not abate them. In all reported cases where other departments are interested, a copy of that portion of the report should previously be sent to the officer concerned, and in matters likely to result in the advice of the town-clerk being asked for by the committee, that officer should not only have a copy of the report beforehand, but all the particulars bearing on the case should also be supplied to him. This will often prevent loss of time, which would occur if the matters were referred to him by the committee for his report thereon at the next meeting, as he will thus be enabled to give his answer at once.

In reporting things likely to result in **legal proceedings** being taken against someone, the person's name should not be mentioned, for reasons which are obvious.

SECTION XVI.

THE IMPROVEMENT OF EXISTING HOUSES

BY

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SECTION XVI.

THE IMPROVEMENT OF EXISTING HOUSES.

CHAPTER I.

DAMPNESS.

The visibly-predominant fault of old houses is generally dampness, with its train of rot, mildew, unsightliness, discomfort, and ill-health; and of all the ills to which houses are heir, this is undoubtedly the worst to cure, as it is so often a disease of the very fabric itself. The dampness of houses may be conveniently considered under three heads:—1. The Basement; 2. The External Walls; and 3. The Roof. Useful information on these subjects will, it is hoped, have been found in Section II., "Construction", and the reader is referred there for fuller details of those methods and principles, which are here only briefly mentioned. New difficulties, of course, present themselves in the repair of existing houses, and an attempt will be made to consider some of these difficulties more fully. It will be impossible, however, to discuss every defect which may occur in a building, and only those will be considered which are generally known as "sanitary defects", using the term in a broad sense.

1. *THE BASEMENT.*

Subsoil-drainage will seldom be found under or around old houses, or, if drains were originally laid, they were probably of stone, and have either collapsed or been choked with silt. In damp situations, houses will often be made drier by laying deep subsoil-drains around the house, without disturbing the fabric itself. These drains must, as explained in Section II., Vol. I., pp. 79–81, be disconnected from the sewage-drains. Where necessary, branch subsoil-drains must be carried under the house to the specially damp places.

Damp basement-floors, whether of flags or tiles, may be covered at once, if the height of the room will allow, with a thin coat of cement (for the purpose of

levelling the floors), on which one or two coats of natural or artificial asphalt may be spread, and the surfaces can then be formed with grit rolled into the asphalt, or with tiles, flags, or wood-blocks, or with a layer of fine concrete about $1\frac{1}{2}$ inches thick. Where the height of the room must not be reduced, the old floor must be taken up, the ground excavated to a depth of at least 6 inches, and an impervious ground-layer and floor formed, consisting of a $4\frac{1}{2}$-inch bed of compact concrete floated to a smooth surface and covered with an asphalt layer, which may be finished with a concrete or other surface as described above, after the manner of the floor shown in fig. 42, p. 91, vol. i.

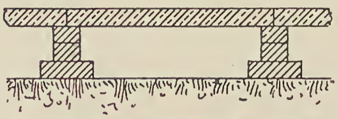


Fig. 678.—Flagged Basement-floor with Air-space beneath.

Sometimes basement-floors in damp ground are formed with flags, artificial or natural, with the edges resting on low sleeper walls, as shown in fig. 678, or with the corners carried on small piers of stone, brick, or concrete. The latter arrangement is suitable for artificial flags, all of the same dimensions, but the other is the more economical for natural flags. This method has little to recommend it save economy; the spaces under the flags, while undoubtedly tending to the dryness of the floor, do not prevent the ground-air entering the building, and furnish a convenient harbour for cockroaches and other vermin.

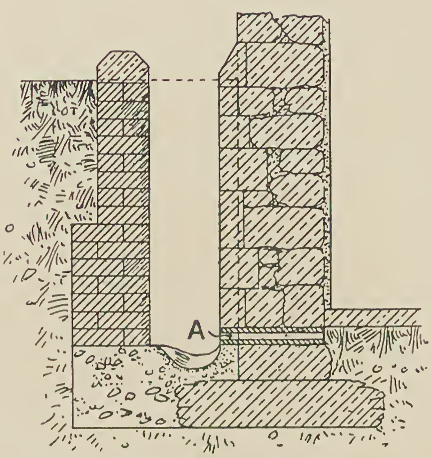


Fig. 679.—Old Stone Wall faced with New Stone, after forming open Area. A, new damp-course.

The dampness of basement-walls will probably be considerably reduced by drainage of the subsoil, but one of the greatest improvements will be the formation of an open area around the building, as shown in fig. 38, p. 66, vol. i., or of a dry area (although this is less satisfactory), as shown in fig. 40, Nos. 2–3, p. 89, vol. i. If an open area is formed in connection with a stone building, the outside of the walls will probably prove to be very rough, and must be either roughly brought to an uniform surface and then covered with cement stucco, or faced with new stone which can be finished at the top with a chamfered base, as shown in fig. 679; or the whole of the outer thickness of stone can be cut out, and this part of the wall underpinned with stonework in cement mortar, but this method will prove very expensive. A perforated damp-course, as shown at A, will assist in keeping the wall and floor dry.

Where the formation of an open area would prove too costly, and where it is

impossible to drain the subsoil sufficiently deep, on account of the relative depths of the basement and of the available outlet, some other method of obtaining dry walls within the basement must be adopted. One method consists in building a $4\frac{1}{2}$-inch brick wall on the new ground-layer or floor, leaving a cavity, not less than 2 inches wide, between it and the old wall; this cavity must be closed at the top, and ventilated by means of grated openings into the basement at or near the floor-level, and into the open air above the ground, as shown in fig. 680. If the rooms in the basement will be reduced too much in size by the arrangement just shown, the new brickwork may be built on edge, and will then be only 3 inches thick instead of $4\frac{1}{2}$ inches.

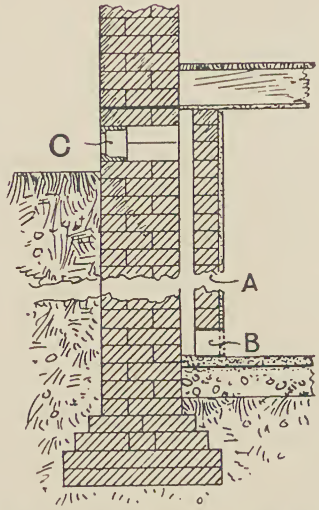


Fig. 680.—Section showing Inner Wall and Ventilated Cavity for improving Damp Basements. A, new brickwork forming cavity; B and C, air-grates.

Still greater saving of space will be effected by forming the cavity only $\frac{1}{2}$ or $\frac{3}{4}$ inch wide, and running it full of **artificial asphalt** every three courses; the basement-rooms in this case would only be reduced 5 inches at each external wall, or, if the bricks are built on edge, only about $3\frac{1}{2}$ inches. See pages 87–88, and 90–92, Section II., Vol. I., for further information as to asphalts and their application. It will be gathered from reference to these pages that an excellent arrangement would be the covering of the exterior of the wall with an asphalt layer; but this would entail a great expense in excavation, preparing the wall, &c., but the cost of the brick lining would be saved.

Plates of asphalt are now made by the Limmer Asphalt Paving Co. for affixing to damp walls, but these can only be used where appearance is not of much importance.

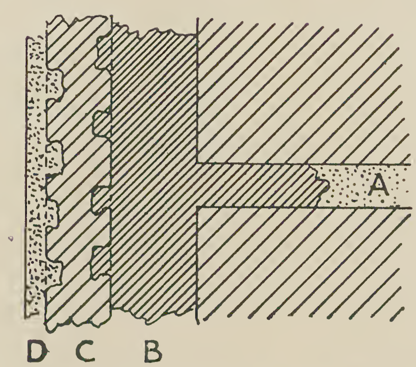


Fig. 681.—Full-size Section of White's Tiles, with Asphalted Cavity for Damp Walls. A, mortar-joint with part raked out; B, asphaltic composition; C, tile; D, plaster.

A more ingenious arrangement, and one more generally applicable to the damp walls of basements, has been devised by Mr. William White, and consists in the use of **unglazed tiles with an asphalt lining** between them and the wall. As shown in fig. 681, the tiles are roughened on both sides to secure the thorough adhesion of the asphaltic composition on the one side and the plaster or cement on the other. Before laying the tiles, the plaster must be removed from the face

of the wall, and the joints well raked out to afford a key for the composition; a row of tiles is then placed in position about half an inch from the wall, and held there by means of a simple wood framework. Into the cavity thus formed, the molten composition is poured, and in a few minutes sets sufficiently to allow the framework to be raised and another row of tiles placed in position. A coat of plaster or cement applied to the exposed face of the tiles completes the work. The total thickness of this damp-proof lining, including composition, tiles, and plaster, need not exceed an inch or thereabouts. The asphalt lining may be connected with the asphalt floor-layer, and a continuous damp-proof covering be thus obtained.

2. *THE EXTERNAL WALLS.*

The dampness of external walls above-ground is often a more annoying evil than that of damp basements. It may be due to the rising of moisture from wet ground, to the splashing up of rain-water dropping from faulty eaves, to leaky lead flashings in parapet-gutters, flats, roots of chimneys, &c., to leaky coping on parapets and gables, or to rain being driven or drawn through the materials of which the wall is built.

It is not a difficult matter to fix **eaves-troughs** where none have been before, or to repair or renew existing troughs. In exposed situations, the roof should overhang the walls a foot or 18 inches at all eaves and gables; this is an almost certain preventative of damp in at least the upper parts of the walls, but it is a method which cannot be applied to existing houses without much trouble and expense.

Lead flashings may admit rain in consequence of being inadequately pointed. Careful pointing with oil mastic may remedy the defect. Sometimes, however, damp walls are caused by the gutter being filled with snow above the top of the flashing, and when the snow melts, the water soaks into the wall or ceiling, provided that it cannot escape very rapidly through the outlet.

The leadwork around **chimney-stacks** may be considered at fault, when really the blame rests with the bricklayer or mason. A half-brick wall, built probably with ordinary mortar, often forms the external structure of the chimney-stack; it is no wonder, therefore, if, in the exposed positions which chimney-stacks usually occupy, it is little or no protection against driving rain, not only becoming thoroughly soaked with moisture, but even allowing the rain to pass through it and run down the flues. This, and not the lead-flashing, is often the reason why damp spots appear on the plaster below chimney-stacks. The defect may sometimes be merely a question of pointing; in which case,

the joints must be raked out and well pointed with mastic or with Portland-cement mortar (not containing more than two parts of sand to one of cement). If the bricks themselves are too porous, the stack must be taken down, and rebuilt (9 inches thick if possible) with dense bricks laid in cement mortar, all the joints being thoroughly flushed; a damp-course of lead, inserted immediately above the lead flashings at the root of the stack, will assist in preventing moisture soaking into the walls below.

The dampness of main external walls is often a more serious matter. Some building-stones and bricks are so porous that, in continued wet and boisterous weather, moisture penetrates throughout their substance, and rapidly discolours or destroys the decorations on the inner face of the wall. The radical cure suggested for the chimney-stack will scarcely be considered applicable in this case by the average householder, who will usually try every method under the sun rather than rebuild the house or the offending side of it. The method which is usually first attempted, consists in pointing all the joints with cement or mastic, after raking out the old mortar. If this fails, a so-called damp-proof wash or covering is generally applied to the inside surface of the wall, then the wall is papered again in the ordinary way.

Damp-resisting washes are undoubtedly of some service; among these are Szerelmey's Stone Liquid, Orr's Petrifying Liquid, Carbolineum Avenarius, and Morse's Damp-resisting Solution. The principal merit of this method of treatment is its economy; it has also the advantage of not altering in any way the appearance of the building outside, as is the case when the solutions are applied to the external face, but it has the great defect of allowing the rain still to penetrate the wall, which entails a slow but sure decay of the materials of which this is built, as well as coldness within the house. The proper method of procedure is to apply the water-proof coat to the outside of the wall, and so prevent the moisture entering the wall at all. Most, if not all, of the washes in the market unfortunately discolour to some extent the surfaces to which they are applied; the effect is more noticeable in the case of new stonework than of brickwork. These solutions should only be applied when the walls are perfectly dry, and care should be observed before applying them to remove all dirt, lichen, paint, and other matter, which might prevent the solution soaking thoroughly into the pores of the structure. At the best, however, the beneficial effects are only temporary, and in exposed situations the solutions appear to be of comparatively little use.

Oil paint, or some preparation containing linseed-oil, is also applied to damp walls externally, but must be renewed at intervals.

Portland-cement stucco often cures a damp wall, but is less objectionable in appearance when covered with "rough-cast".

Covering the offending wall with **slates** is almost invariably successful, but is certainly costly.

Weather-tiling serves the purpose equally well at a slightly additional cost. It may sometimes suffice to cover only the upper part of the walls; in such a case, the tiles may have an overhang at the bottom, which, if large, must be formed by "sprocket-pieces", as shown in fig. 682. The tiles must be nailed into the joints of the wall, or, where this is not possible, to horizontal and vertical wood laths secured to the wall at the required distances, as shown in the illustration. Tiles 9 inches by 6 inches are now made, the vertical section being shaped thus ┕┑. Each row is nailed into the joints of the brickwork, and overlaps the tiles below, so that the appearance of brickwork is retained.

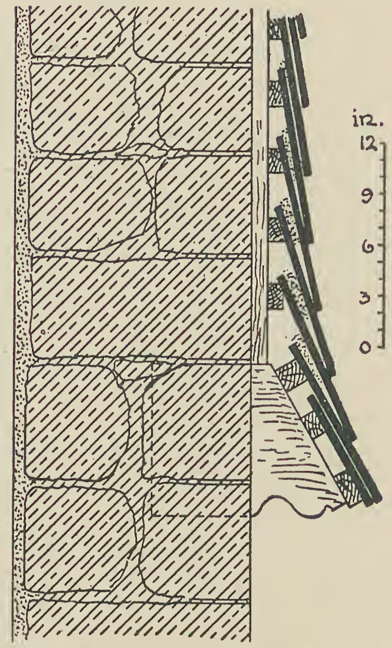


Fig. 682.—Section showing a Method of Covering an Old Wall with Weather-tiles.

The formation of a kind of hollow wall, by means of **a partition within the room** (see page 119, vol. i.), is a remedy often adopted.

Where the damp rises from the ground into the wall, it will usually be found that a damp-proof course has not been inserted. The radical remedy would be to cut out the walling below the ground-floor and above the external ground, a little at a time, and to insert a suitable damp-course—as shown at A in fig. 679,—and make good the walling with stone or brick, as the case may be, bedded in good cement mortar. This is, of course, a very expensive operation, and house-owners are not always willing to sanction it. Drainage of the subsoil and excavation of the external ground to as great a depth as possible will do something to improve matters, and an external rendering of cement mortar from the foundation to the ground-floor will also tend to prevent the ground-water entering the wall. Sometimes the base of a wall is damp in consequence of rain-water pouring from the roof and splashing up from the ground on to the wall; when this is the case, an eaves-trough provides a simple remedy.

3. *THE ROOF.*

When a roof leaks, it will generally be found that the **slates or tiles** are laid on laths without boarding or waterproof paper or felt beneath. Possibly the leak occurs at a broken slate or tile; the defect may be remedied by the insertion of a new one, secured by a holdfast of lead or zinc. Sometimes the slates or tiles are laid with insufficient lap, and the slightest defect in the "torching" or "pointing" permits the ingress of water; in such a case the pointing must be periodically examined and repaired, or the roof-covering must be taken off and relaid in a more substantial manner, as explained in Chapter VII., Section II., Vol. I. In exposed situations external pointing is sometimes adopted, but it is always unsightly and does not last long.

The leadwork of roofs is a common source of leaks. If the lead was originally laid in sheets of excessive size, so that they were not free to expand and contract without crumpling the lead into folds, the cracking of the lead is only a question of time. Soldering the crack is merely a temporary remedy; the only permanent cure is to relay the lead with suitable rolls and drips, so that every piece is free to expand and contract. Leaks in leadwork may be temporarily stopped by covering the crack with a tape well painted with white-lead.

The lack of snow-boards often allows dampness beneath lead flats and gutters, as the melting snow is prevented from finding its way to the outlet, and as this is in all probability blocked with snow. When snow-boards are provided, not only is the snow prevented from coming into contact with the gutter or flat, but, on melting, the water has a clear passage to the outlet. It is an easy matter to place snow-boards on roofs, as no alteration of the existing work is required.

The stoppage of rain-water pipes, especially those leading from flats and gutters, is a frequent cause of dampness in the rooms beneath. Usually the entrance to the pipe is choked with leaves. The remedy is simple, and consists in inserting a cage of copper or galvanized wire into the top of the pipe, and in taking care to have the roofs regularly cleared, particularly in autumn.

If, as is frequently the case in old buildings, **the woodwork of the roof** has given way, resulting in considerable damage to the slates or tiles, the best way will be to remove these and either to construct a new roof or to insert new timbers where necessary. To avoid disturbing the plaster under the rafters, fillets may be nailed to the sides of the rafters, and strong plasterers' laths can be nailed to them, above which a layer of cement mortar can be spread to serve as torching, the slates being laid on the mortar and nailed to battens in the usual way.

CHAPTER II.

WOODWORK.

The improvement of the woodwork of a house need not be considered in detail. Internal doors, stairs, &c., are rather matters of taste than of sanitary importance, and the repair of windows and other joinery can usually be entrusted without much misgiving to any intelligent workman; there is, however, one important question which must be discussed, as it is one which often arises, and which is not always easily settled. I refer to the question of dry-rot.

Dry-rot, as explained by the writer on page 167, vol. i., "is a kind of decay caused by the development of a fungus, the *Merulius lacrymans*, four conditions favouring the growth, namely—stagnant air, dampness, warmth, and absence of light or sunshine". There can be no doubt that the nature of the wood has also a great deal to do with the inception and spread of the disease. I know a case where wood joists are laid actually on the earth and covered with floor-boards, and after a generation no trace of decay is visible; on the other hand, I have known several cases of dry-rot occurring in floors *over* basements. In one of these latter cases the joists were not plastered beneath, but the decay commenced at the ends, which were built into the wall at a point where this was below the external ground. Damp and sappy wood is particularly liable to dry-rot, and should not be allowed in new work.

The practice, common in some parts of the country, of laying stone flags or concrete on the top of a joisted and rough-boarded floor, cannot be too strongly condemned. I have known a floor of this kind collapse within two or three years of its construction; on the other hand, it must be confessed that some floors, constructed in this way forty or fifty years ago, are still apparently as sound as ever. It appears to me that, in these days of cheap contract-work, the quality of the wood used by builders is far inferior to that used a few generations ago, and to this, as much as anything else, must be attributed the greater prevalence of dry-rot, which is found to-day not only in the cottage and cheap villa, but in the mansion and palatial town-hall.

To prevent dry-rot in floors is easier than to cure it. Ventilation must be secured, not only beneath the joists, but also around their ends. This can only be effected by providing sufficient air-grates beneath the floor, particularly in the angles of the room, and by allowing the ends of the joists to rest on offsets of the wall, as shown in fig. 39, page 82, vol. i., or by leaving a space in the brickwork around the end of each joist; the former is the safer plan. Sometimes

special air-ducts must be formed under neighbouring solid floors in order to ventilate the inner angles of rooms; an example of this kind is illustrated in figs. 683 and 684. Care must also be taken by the householder lest the grates provided by the architect be covered with litter or garden-mould; at least one case of dry-rot, due to neglect of this simple precaution, has come under the writer's notice.

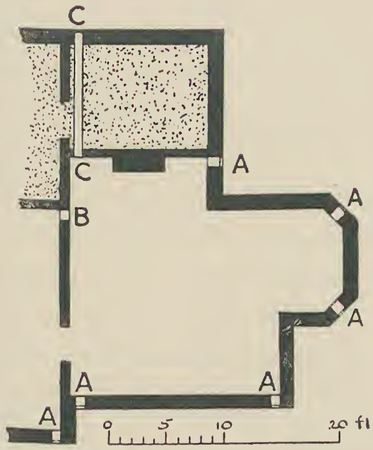


Fig. 683.—Plan showing Ventilation of Space under Wood Floor.

A A A, air-grates: B, air-opening; C C, air-drain under solid floor.

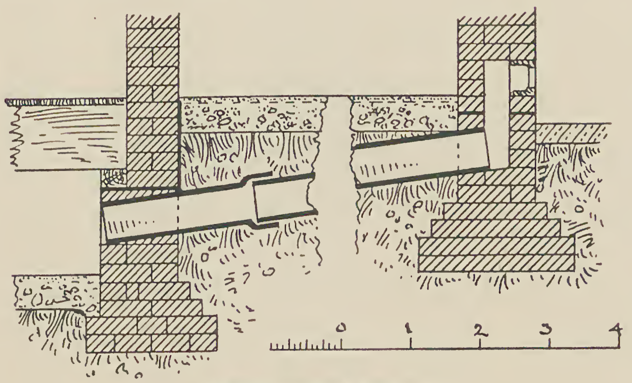


Fig. 684.—Enlarged Section at C C.

The cure of dry-rot is often a very difficult matter. In its early stages, dry-rot may sometimes be prevented from spreading, by thoroughly scraping and drying the wood, and covering it with some antiseptic solution, such as carbolineum avenarius. Probably the mischief has begun at the ends of joists inserted in a damp wall; if so, the walling around must be opened out, and the wood carefully treated. In bad cases the only remedy which can be recommended, is the radical one of removing the floor, thoroughly cleaning the walls and space beneath the floor and washing them with "hot" lime so as to destroy all spores, and laying a new floor of better materials.

No cure can be permanent, however, which does not include the provision of sufficient air-grates suitably placed beneath the floor, and the prevention of dampness, especially in the walls at the ends of the joists.

While dry-rot usually occurs in situations alternately moist and dry, **wet-rot** is caused by excessive dampness, and is often seen in window-sills, fence-posts, the feet of door-posts, and other exposed woodwork. It does not spread with the rapidity of dry-rot, and the cutting out of the affected piece and replacing with new are not usually laborious operations. Where the ends of beams have begun to decay, brackets can sometimes be secured to the wall beneath and the decayed parts cut away, as shown in fig. 685.

Old wood floor-boards are often warped, and the joints so open as to hold

a large quantity of fine dust. Planing will do something towards levelling the surface, and the widest joints may be filled with strips of wood, while the remainder may be stopped with putty. The floor can then be stained and varnished. In bedrooms especially floors finished in this way are desirable, on the score of cleanliness and convenience. Better surfaces can, of course, be obtained by covering the floors, after levelling, with thin parquetry, which can now be obtained in removable slabs. Cork carpet, glued to the floor after this has been planed, also forms a satisfactory surface, which can be easily washed and does not need removal.

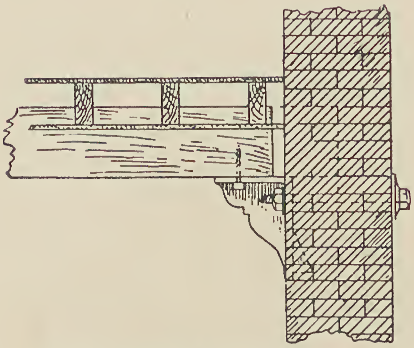


Fig. 685.—Bracket to support End of Beam, with decayed part cut away

Paints of various kinds are well-known preservatives of wood, the paint most commonly used consisting chiefly of white-lead, oil, and colouring matter. Paints with a base of zinc-oxide are, from a sanitary point of view, far preferable to those containing white-lead, as the latter are a certain cause of illness and premature death to the artizans who are regularly engaged in manufacturing or using them, and sometimes during drying cause sickness among the occupants of the building where they have been used.

CHAPTER III.

SMOKY CHIMNEYS.

The subject of smoky chimneys is undoubtedly most important and most difficult. In Chapter VI., Section II., Vol. I., certain rules were laid down for the construction of fireplaces, flues, and chimney-stacks, and a perusal of these will, it is hoped, be of some service in connection with the cure of smoky chimneys, although they do not cover the whole ground. The defects of existing chimneys may be defects of *construction* (including form, size and workmanship) or of *position* (including fireplace, flue, and stack).

Defects of construction, if due to bad workmanship, may not be very serious; perhaps a few bricks or some large droppings of mortar have partially blocked the flue. These can be discovered by the sweeper, and can usually be removed by dragging a suitable "core" down the flue; if not, their position can be

approximately ascertained, and they can be removed after cutting out the brickwork in front.

If the flue is in any part too nearly horizontal, it can only be remedied at considerable inconvenience and expense. One case of this kind was altered by the writer, as shown in fig. 686, with very satisfactory results, new windows being at the same time inserted in order to light and ventilate the attics. The defect, however, cannot always be so easily removed.

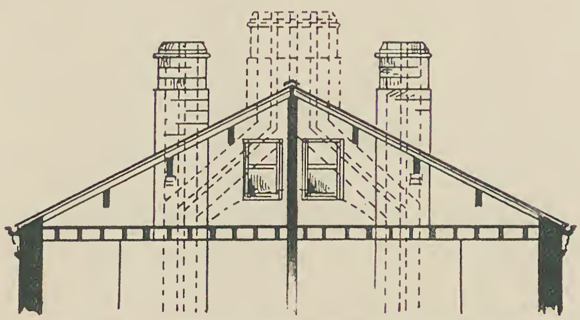


Fig. 686.—Alteration of Chimney-stacks in consequence of insufficient Inclination of Flues.

The size of the flue is often a serious fault. In old houses especially, the flues are usually much too large, having been built in the days when boys climbed the flues in order to sweep them. As a rule, such chimneys smoke when the fires are first lighted, but cease to smoke when the whole of the flue is thoroughly warmed. A good plan is to burn some shavings for a short time before laying the coals. The lessening of a flue is not an easy matter. The lowest part (which is often the worst) can be bricked up to a considerable height, after removing the range; perhaps the best method of completing the reduction is to cut holes into the flue at intervals, and place 9-inch drain-pipes or flue-pipes within the old flue.

The construction of the chimney-stack is often defective. If the brickwork of the stack is thin and porous, it may become soaked with rain, and thus chill the air in the flue and so reduce the draught. Pointing the joints, or covering the stack with stucco, may do some good, but reconstruction in a more substantial way and with better materials is the most thorough remedy; a damp-course of lead or other material, inserted immediately above the roof, will prevent moisture soaking into the rooms below. The "mid-feathers", or brickwork between the several flues, sometimes give way, and thus help to choke the flues, while at the same time the smoke from one flue may be drawn down another flue into the house. The cure of this defect is obvious.

The lack of air-inlets in the room is often the cause of unsatisfactory draught in the flue. In his Report on "Sanitary Works at Windsor Castle, 1863", Sir (then Mr.) Robert Rawlinson wrote: "To prevent smoky chimneys, about seventy of the most troublesome rooms have been ventilated and otherwise improved". Another extract from the same report gives an example of improving large flues in the way indicated in the last paragraph but one: "In the numerous

structural alterations made in Windsor Castle, the old large and open chimney-spaces of mediæval periods have been made good. All new chimney-flues are lined with fire-clay tubes, flushed and grouted-in solid."

The position of the fireplace cannot usually be altered without very great expense. It may, however, be pointed out that fireplaces against external walls often smoke on account of the flue being chilled. Any external protection, such as weather-tiling, will be of service in cases of this kind.

The position and height of the chimney-stack are very frequent causes of smoky fireplaces. Chimney-stacks rising from the eaves of a roof are great sinners, and sometimes the defect can only be cured by raising the stack a little higher than the ridge of the roof, and crowning it with a suitable cowl. Chimney-stacks on gables are also liable to blow-downs, when the wind is in the direction of the ridge. The neighbourhood of loftier buildings, trees, rocks, &c., causes smokiness in chimneys, in consequence of gusts of wind blowing over the loftier objects and sweeping down upon the flues. The houses in mountainous districts furnish lessons for us in cases like these. In the Pyrenees and the middle of Corsica, as well as in the Alps and the mountainous parts of our own country, I have been struck with the diminutive chimney-stacks, which the builders have deemed sufficient. Many of them, even when placed near the eaves, do not rise more than a foot or two above the roof, but almost invariably the top of the flue is covered, and the smoke escapes through openings in the sides of the stack. Sometimes the covering is a flag supported on a stone at each corner, and perhaps weighted with a large stone to prevent it being blown off. Sometimes the cover is formed with two flags or slates, sloping to a ridge over the flue. The important feature of all is that a direct blow-down is impossible, and my experience is that chimney-cowls with side openings and with the top covered are more frequently successful in preventing blow-downs than any other kind.

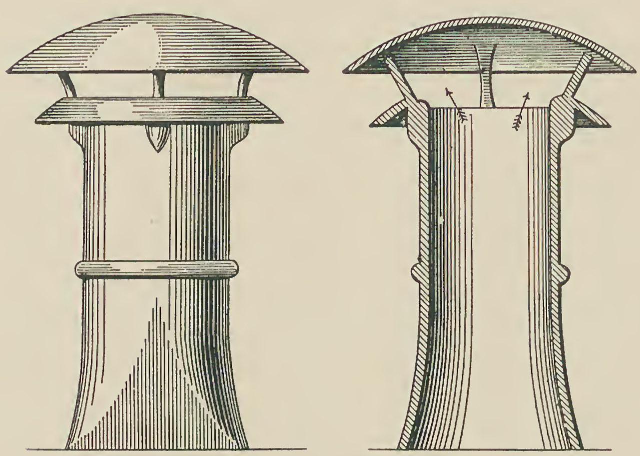


Fig. 687.—Elevation and Section of the Pembridge Chimney-cowl.

The Pembridge chimney-cowl, illustrated in fig. 687, is a simple example of this kind. I have tried it on a troublesome flue, on two sides of which are loftier buildings, and it has proved quite satisfactory; it has, however, the

disadvantage of great breadth, and cannot be used for a series of flues of ordinary size. It is also somewhat difficult to sweep, as the top is fixed.

Green's patent chimney-pot is an ingenious contrivance. As shown in fig. 688, it can be obtained either with or without the covering at the top. The makers recommend that the pot alone should first be fixed, "as this usually effects a cure, but if this is not entirely successful, then the cowl, which is of cast-iron and drops in at the top of the pot, may be added". On removing the cast-iron "cowl", the flue and pot can be easily swept.

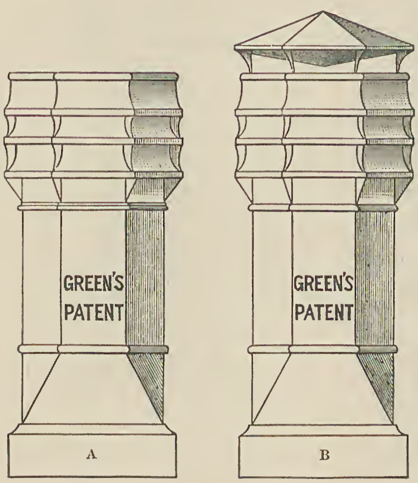


Fig. 688.—Green's Patent Chimney-pot.
A, without cowl; B, with cast-iron cowl.

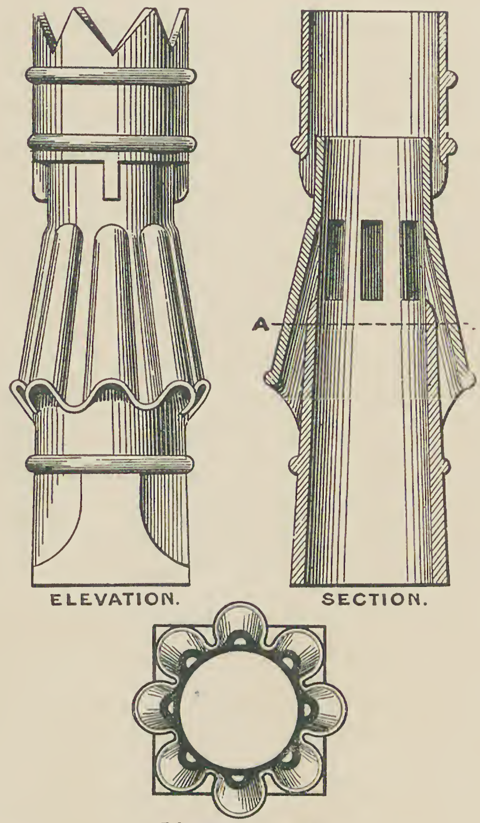


Fig. 689.—Elevation, Section, and Plan of the "Success" Chimney-pot.

This pot and cowl together will undoubtedly prevent a blow-down in nearly every case.

Cowls with fast tops, such as the Pembridge cowl, interfere somewhat with the sweeping of the flue, and attempts have therefore been made, as in **the "Success" chimney-pot,** to prevent blow-downs by providing outlets in the sides of the pot, while leaving the top uncovered. The arrangement is not always satisfactory.

The three cowls illustrated in figs. 687, 688, and 689, have the great advantage of being made of fire-clay or glazed earthenware, these materials being practically indestructible by ordinary agencies.

Cowls of sheet-iron or steel soon corrode, and should only be used when earthenware or fire-clay cowls have failed to effect a cure. Fig. 690 shows a common form. I have found Boyle's cowl (fig. 691) successful, but it will only last a few years. The "lobster-back" cowl and the rotary cowl are also used, but it is best to avoid appliances with movable parts wherever possible, as they require regular attention, and are not very durable; moreover, some of them are very noisy. A somewhat curious metal cowl, without movable parts, is shown in fig. 692; it is known as Cooper's patent "Acme", and is said to have proved satisfactory in many cases.

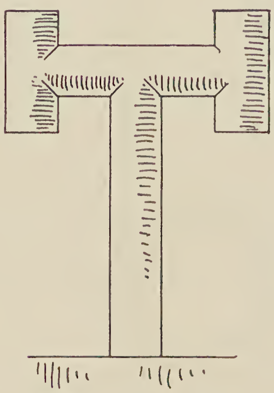


Fig. 690.—Chimney-cowl of Sheet Iron or Steel.

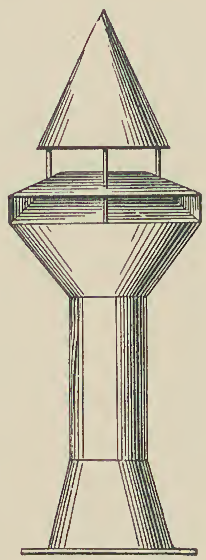


Fig. 691.—Boyle's Chimney-cowl.

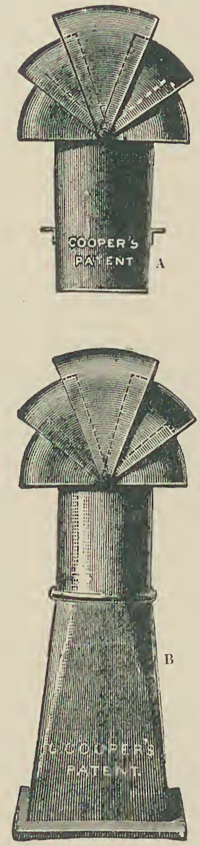


Fig. 692.—Cooper's "Acme" Chimney-cowl.

A, for fitting on existing chimney-pots; B, with square base and flange.

CHAPTER IV.

DEFECTIVE PLUMBING AND DRAINAGE.

The removal of sanitary defects is often a most expensive operation, involving, in many cases, structural alterations of considerable magnitude, such as the formation of water-closets and bath-rooms in new positions, so as to obtain light and air, and facilities for the satisfactory removal of the waste

matters. It is often easier and less costly to put entirely new sanitary fittings into an old house, than to make perfect the fittings of a more modern house, built in the days when "conveniences" were accounted necessary, but before the true principles of plumbing and drainage were known. Many houses, erected only twenty or thirty years ago, are more dangerous to the occupant than houses which have stood for a century or more; in the latter there are no "sanitary" fittings and no drains, whereas the former may contain the foulest appliances connected with internal soil-pipes and cesspools, which allow deadly gases and germs to pass into the several apartments.

It is, of course, impossible to mention every defect which may be found, but an attempt will be made to point out the most important, and to suggest remedies. In doing this, advantage will be taken in this chapter of the valuable report of "*The Lancet* Special Commission on the Relative Efficiency and Cost of Plumbers' Work".

"The Lancet" Special Commission prepared illustrations of three typical houses, containing almost as many sanitary defects as possible, and then proceeded to point out the defects and to suggest remedies. These houses are shown in Plates XXV. and XXVI., and in fig. 698 (p. 396), which are here reproduced through the kind permission of the editor of *The Lancet.* It will be unnecessary to enter fully into all the details of the report, as many of them are matters which have been dealt with already in these volumes, especially in the sections on "Domestic Water-supply", "Sanitary Plumbing", "Sanitary Fittings", and "Drainage"; but sufficient will be said to indicate the principal defects, and the radical nature of the alterations required to bring the house up to the modern standard.

Plate XXV. illustrates **a terrace-house of considerable size,** the left-hand drawings showing the original arrangements, and the right-hand showing the house as proposed to be altered.

The roof consists of two slated bays with a lead flat between, and with a lead-lined parapet-gutter at the front and back. The water from the front gutter descends the cast-iron rain-water pipe A, which is trapped at the foot, but not disconnected from the drain; the gases in the drain may therefore be drawn through the trap (especially in dry weather, when the trap may be unsealed by evaporation), and may pass out through the open joints of the rain-water pipe, and be drawn into the house through the adjacent windows. The pipe A "should be cut off at the bottom from the drain, and connected with an easy bend and short length of pipe into side inlet of new gully F F".

The rain-water pipe B is designed not only to take the water from the valley

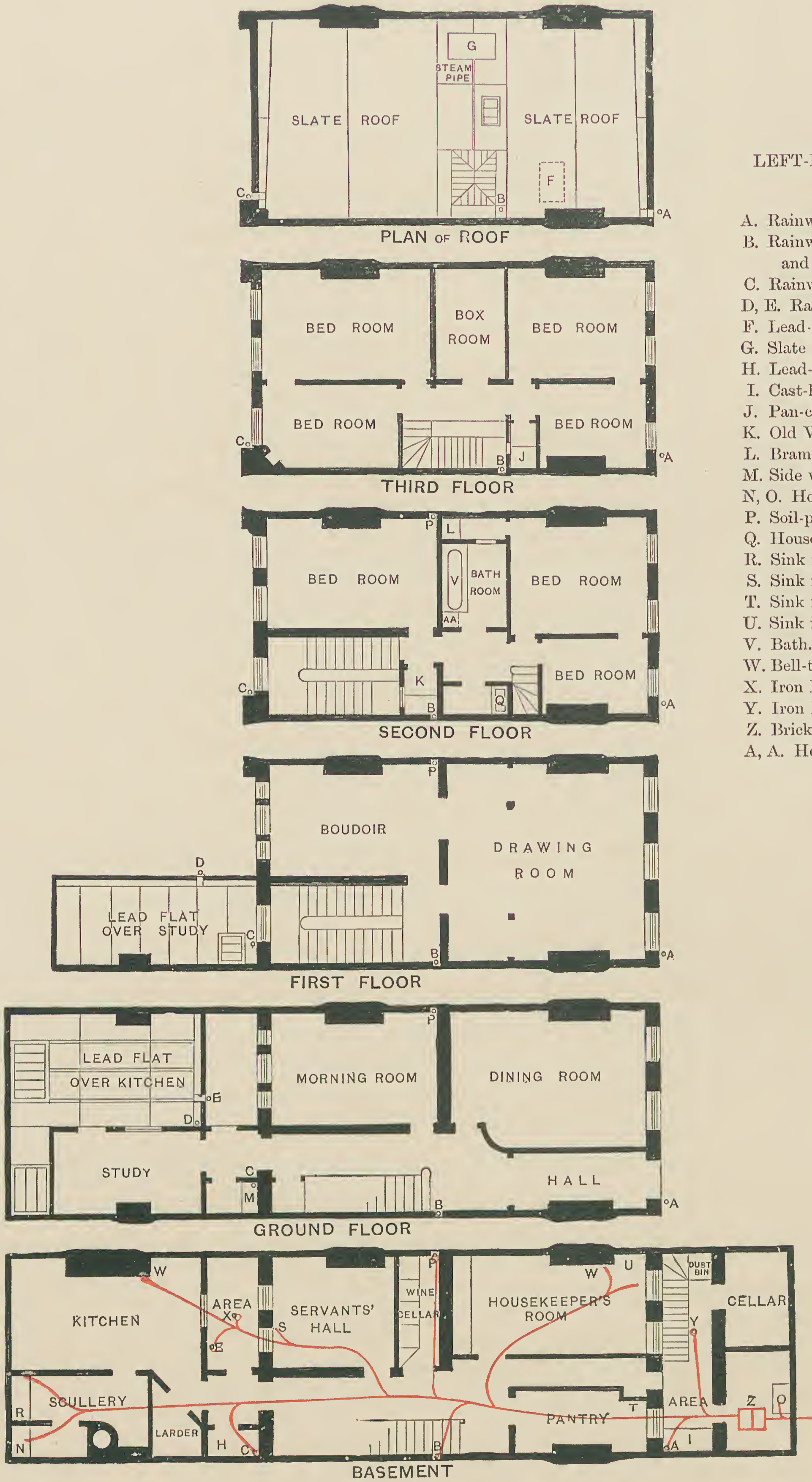
and flat of the roof, but also to serve as the soil-pipe for the closets K and J on the second and third floors. It is $4\frac{1}{2}$ inches in diameter, and trapped at the foot. There are several objections to this pipe. In the first place, it is a serious error to allow one pipe to serve both as rain-water pipe and soil-pipe, particularly when the drains are not otherwise ventilated; in the second place, the soil-pipe is within the building, and terminates too near the skylight on the roof; moreover, the water-closets are in the middle of the building, and consequently most inadequately lighted and ventilated. The Commissioners recommend that "this pipe should be carried down the same course as before, either in cast-iron or lead, the latter for choice, and continued under the basement-floor in a 4-inch stoneware drain-pipe, to deliver over the gully F F in the front area. This drain must be laid on a 6-inch bed of concrete, and the lead down-pipe connected with it by a brass sleeve-piece or thimble." In the writer's opinion an iron drain would be better than the stoneware drain laid on concrete.

The rain-water pipe C is of cast-iron, and receives the soil from the ground-floor W.C. marked M; it is trapped at the bottom. "This pipe should be disconnected, and made to discharge on the flat over the study after removal of old soil-pipe."

As the rain-water pipe D delivers on the flat over the kitchen, it is satisfactorily disconnected from the drain, and does not require alteration.

The rain-water pipe E, however, is connected directly with the drain; as the trap at the foot cannot be relied upon to prevent the passage of air from the drain into it, especially in dry weather, the pipe should be disconnected, and provided with a shoe, made to discharge over the new flush-tank.

The water-service next demands consideration. The cistern marked F on the roof-plan is lined with lead, and has a trapped overflow connected with the soil and rain-water pipe B. It contains a standing waste, punctured near the top in order to keep the trap recharged when the water is on from the main. A service-box, for supplying the W.C. marked J, is fitted in the cistern. Lastly, the cistern is without lid, and consequently contains a quantity of dirt from the roof. The following recommendations are made in connection with this cistern:—"A dormer enclosure should be formed in the roof to hold the cisterns, as shown on plan, with a door on to the roof; there should be either stud-and-board or lath-and-plaster sides to keep out the dirt, and the sides and roof should be covered with 6-lb. lead; . . . the dormer should be provided with louvres to admit fresh air, and with a wooden door to close the same in winter; it could be lighted from a skylight or sash, which should be made to open, as this would also light and ventilate the old W.C. J, which will now be used for housemaid's sink Q; this



REFERENCES TO
LEFT-HAND SECTION OF PLATE
(OLD ARRANGEMENTS).

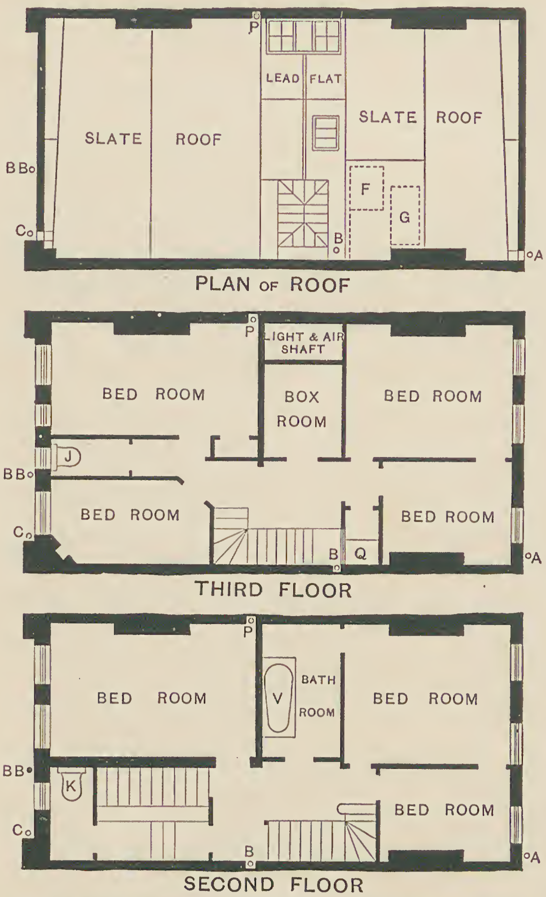
A. Rainwater-pipe.
B. Rainwater-pipe and soil-pipe from J, K, and Q.
C. Rainwater-pipe and soil-pipe from N.
D, E. Rainwater-pipes.
F. Lead-lined Cistern in roof.
G. Slate Cistern in lead flat.
H. Lead-lined Cistern in cupboard.
I. Cast-lead Cistern in area.
J. Pan-closet.
K. Old Valve-closet.
L. Bramah Closet.
M. Side wash-out closet.
N, O. Hopper Closets.
P. Soil-pipe.
Q. Housemaid's Sink under stairs.
R. Sink in Scullery.
S. Sink in Servants' Hall.
T. Sink in Pantry.
U. Sink in Housekeeper's room.
V. Bath.
W. Bell-traps under Boiler-taps.
X. Iron D-trap.
Y. Iron Bell-trap.
Z. Brick Dip-trap.
A, A. Hot-water Cistern.

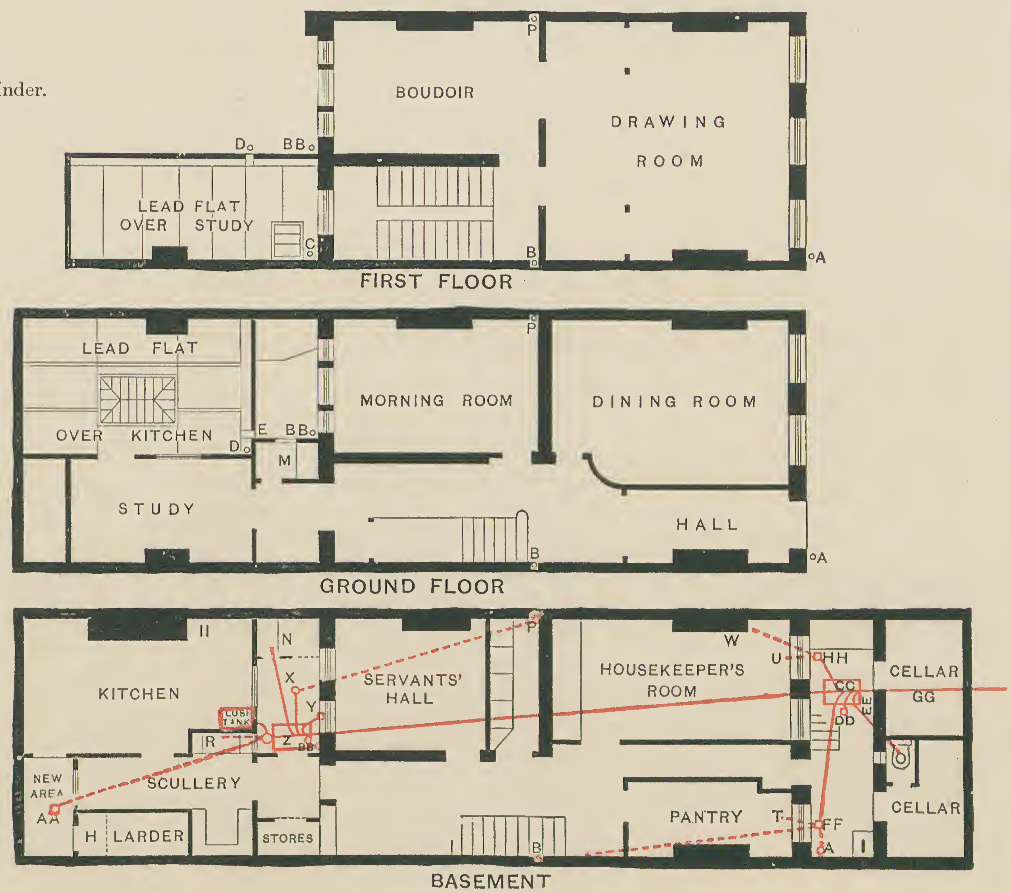
OLD ARRANGEMENTS.

SANITARY ARRANGEMENTS (OLD

REFERENCES TO RIGHT-HAND SECTION OF PLATE (NEW ARRANGEMENTS).

A, B, C, D. Rainwater-pipes.
E. Rainwater-pipe over flushing Gully.
F. Lead-lined Cistern to supply J, K, M, N.
G. Galvanized-iron Cistern to supply Sinks.
H. Galvanized-iron Cistern to supply Scullery Sinks.
I. Galvanized-iron Cistern to supply O.
J. Pedestal-closet.
K. Valve-closet.
L. Old Closet removed.
M. Pedestal-closet.
N. Pedestal-closet for women.
O. Pedestal-closet for men.
P. Bath-waste into X.
Q. Sink (Housemaid's).
R. Sink (Scullery) into flushing Gully.
S. Sink (Servants' Hall) into Y.
T. Sink (Pantry) into FF.
U. Sink (Housekeeper's Room) into HH.
V. Bath into X.
W. Gully disconnected over HH.
X, Y. Gullies.
Z. Inspection-chamber.
A A. Gully with disconnected Drain into flushing Gully
B B. Soil and ventilating Pipe.
C C. Disconnecting Chamber.
D D. Gully.
E E. Air-inlet.
F F. Gully.
G G. Eye for testing Drain.
H H. Gully.
I I. Position of Hot-water Cylinder.





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NEW ARRANGEMENTS.

NEW) OF TERRACE HOUSE, No. 1.

cistern F can be used exclusively for the supply of the W.C.S, and must be moved to a new position for the purpose; a $1\frac{1}{2}$-inch lead overflow-pipe . . . should be provided to deliver into the external gutter; a $1\frac{1}{2}$-inch stout lead service-pipe should be carried down as far as the second floor, fitted immediately under the cistern with a screw-down stop-cock; the cistern should be provided and fitted with a wooden lid."

The cistern G, on the lead flat, is of slate, and holds about 300 gallons. It supplies the water for the bath, W.C. L, and the hot service throughout the house. It is recommended that this cistern be removed, and a new galvanized-iron cistern of $\frac{1}{8}$-inch plate, to hold 300 gallons, be fixed under the new dormer to take its place. This cistern must have a $1\frac{1}{2}$-inch overflow discharging on to the flat, and service-pipes must be led from it to supply the hot-water system, the cold-water tap of the bath, and all the sinks except that in the scullery. A stop-cock should be provided close to the cistern.

Under the closet M there is a lead-lined cistern, supplying the W.C. N in the scullery, the sink R, the copper, and the sink S in the servants' hall. This cistern should, it is said, be replaced by a 100-gallon galvanized-iron tank, fixed in the new larder to supply the sink in the scullery.

The fourth cistern is shown at I, and is of cast-lead; it supplies the W.C. O in the vault, and the two sinks, T and U. In the rearranged system, these sinks will be supplied from the large cistern G; as the cistern at I is too low to flush the W.C. O properly, it is recommended that a new 50-gallon galvanized-iron tank be fixed at a higher level, and protected against frost by a wood casing packed with hair-felt.

It will be noticed that **galvanized-iron cisterns** are recommended, but it must not be forgotten that the house under consideration is supposed to be a London house, and that the water in use in London is hard, and consequently has not much effect on the zinc coating. Soft water decomposes the zinc. This metal is not, however, by any means as harmful to the human system as lead, and the objection to galvanized cisterns is not therefore as strong as to cisterns lined with lead. Attention to the danger of lead-lined cisterns is drawn by the Commissioners in the following words:—"Lead should never be used to line cisterns in which potable water is to be stored, even when the pipes that lead to the sinks may safely be of lead. A piece of bright lead suspended in water or exposed to the air is quickly tarnished from the formation of a film, primarily of lead oxyhydrate. This oxide is soluble in water to a limited extent. Fortunately London waters are hard, and mostly contain considerable quantities of sulphate and carbonate of lime, and form a protective coating of carbonate of

lead, which is insoluble in water unless it contains an excess of CO_2." It is somewhat strange that the Commissioners, after stating, as quoted above, that "lead should *never* be used to line cisterns in which potable water is to be stored", should go on to say that "where an old lead cistern is retained, it should be coated with a cement that will prevent the contact of the water". Such a coating cannot be expected to be permanent.

For the sake of readers in other parts of the country, it should be repeated that soft water, and particularly moorland water, often has a very rapid **solvent effect on lead.** In Oldham, and in many towns in the West Riding of Yorkshire, a vast amount of sickness and many premature deaths have been due to this cause. If the water supplied by the public authority be of this nature, and be the only supply available, the only remedy for the consumer is to remove all lead water-pipes and cisterns from his house, and to substitute tin-lined wrought-iron pipes, or the "Eureka" tin-lined lead pipes (in which an inner tube of tin is separated from the outer tube of lead by a tube of asbestos), and galvanized-iron, slate, or earthenware cisterns; if the supply is constant, cisterns should only be used for the hot-water system and for the water-closets.

The Commissioners recommend that the large **lead service-pipes** be removed, and a $\frac{3}{4}$-inch lead pipe be laid to the new cisterns, a $\frac{3}{4}$-inch screw-down high-pressure stop-cock being inserted in the area, and a ball-valve in each cistern. All pipes exposed in the area, cellar, and roof should be wrapped with hair-felt bound with copper wire.

Nothing is said as to **the use of other metals than lead for pipes,** although this is a most important question when the water has a solvent action on lead. When this is the case, either tin-lined wrought-iron pipes must be used, or the "Eureka" tin-lined lead pipe; in either case the joints must be made by means of special fittings adapted for the pipes. The methods of forming joints and branches in tin-lined wrought-iron pipes have been illustrated and described on page 255, vol. i. A joint in Clarke's "Eureka" pipe must be made as shown in fig. 693; the lead and asbestos must be removed from the end of one pipe for about an inch, and the end of the other pipe must be expanded to receive the projecting tube of tin; when the ends have been brought close together, a "wiped" solder joint must be made in the usual way. The branch-joint requires a special T-piece, as shown in fig. 694, and more labour; the pipe receiving the branch must be *sawn* in two, and the two ends thus made, A and

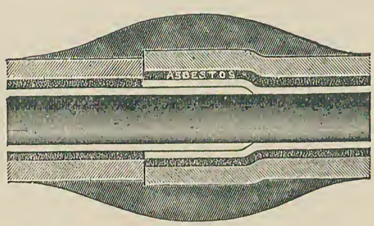


Fig. 693.—Straight-joint in the "Eureka" Tin-lined Lead Pipe.

B, and also the end of the branch-pipe C, must be expanded to receive the projecting tin of the T-piece; when all the ends have been brought close together, the joint can be wiped in the usual way at one operation. Lead pipes washed with tin inside are worse than ordinary lead pipes, and should on no account be used.

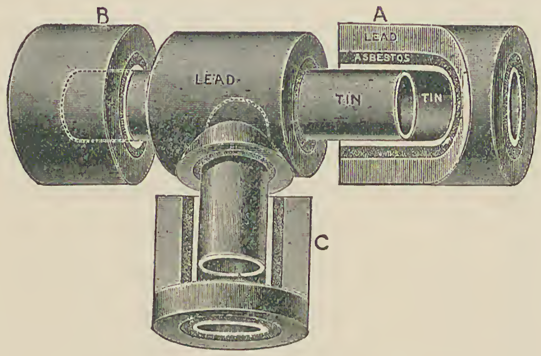


Fig. 694.—Branch-joint in the "Eureka" Tin-lined Lead Pipe.

The water-closets are next considered by the Commissioners. The position of that on the third floor is bad, the reason given being that it is "unprovided with any means of light or ventilation, except on to the staircase". The one valid objection to the position is that it necessitates an internal soil-pipe; both light and ventilation could easily be obtained through the roof. The Commissioners rightly recommend the removal of the closet to the back of the building, where a window can be obtained, and the soil-pipe fixed outside the wall. By the removal of the closet K on the second floor and M on the ground-floor, one soil-pipe is made to serve the three closets; this is an excellent arrangement. The two closets N and O in the basement are both altered for convenience of drainage, a further objection to that marked N being that it is in direct communication with the scullery. The Commissioners rightly remark that "no closet should ever be fixed in a room that communicates directly with another room where food is either prepared or stored; the closet must always be divided from such room by an inclosed lobby, which, as well as the closet, must have direct communication with the external air by either door or window".

The recommendations of the Commissioners with respect to the apparatus themselves need not be described in detail. They include the removal of a pan-closet, a hopper-closet without flushing rim, an old-fashioned valve-closet, and a wash-out closet, and the substitution of modern valve-closets, and wash-down closets with lead traps.

The old 4½-inch seamed-lead soil-pipes must be entirely removed, on account of their position, foulness, lack of ventilation, &c. "The soil-pipe P from closet L is unventilated, and is perforated on the top of the short horizontal length next trap", this corrosion being caused "by the entire absence of ventilation, and the consequent non-removal of soil-gases, as ammonia, carbonic acid, sulphuretted hydrogen, &c.". In addition to the perforation just mentioned,

a fracture had been caused by the repeated expansion and contraction of the lead, owing to the pipe being carried through the wine-cellar in the same casing as the hot-water pipe to the bath, and decay had also taken place in the portion passing through the wall, owing to contact with the lime. On account of the changes of position, the three water-closets J, K, and M can all be served by one soil-pipe. The Commissioners recommend that this be only $3\frac{1}{2}$ inches in diameter, and made of lead weighing 10 lbs. per foot. "Each length [presumably of 10 feet] must be provided with six cast-lead tacks, weighing about 7 lbs. each, soldered on the soil-pipe in pairs at equal distances throughout. The bottom of the pipe must be fitted with a stout brass thimble, soldered to same for connection with the iron branch to manhole." It is also said that the upper end of the pipe "should be carried up over the parapet to about 2 feet above the ridge", as shown in fig. 695, which is copied from one in the report. This recommendation is of questionable value, as the two bends thus introduced will very greatly reduce the air-extracting power of the pipe; if there had been a skylight on the side of the roof nearest the pipe, there would have been a valid reason for carrying this above the ridge, but in any case the outlet near the ridge brings the foul air of the soil-pipe and drain nearer the central skylights and the louvred dormer inclosing the water-cisterns.

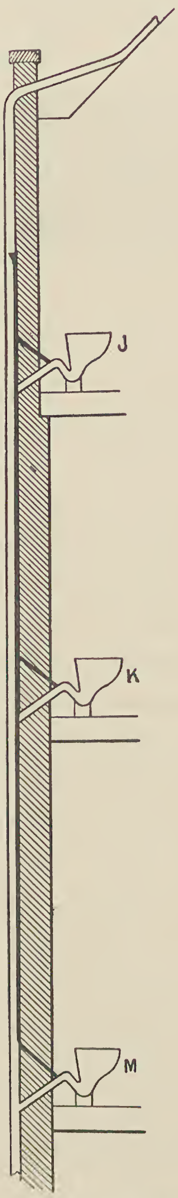


Fig. 695. — Section showing Soil-pipe for a Tier of Three Closets, with Anti-syphonage Pipe, &c.

The anti-syphonage pipe recommended by the Commissioners is shown in fig. 695. It is to be of strong lead, 2 inches in diameter, and carried up outside the building from the branch of the lowest closet to a point above the highest closet, and there connected with the upper part of the soil-pipe. Branch anti-syphonage pipes are taken from the traps of the two upper closets into the main pipe.

The housemaid's sink Q on the second-floor landing is of wood lined with lead, and the waste-pipe is "connected into the side of the D-trap of the W.C. K". The position of the sink is, we are told, faulty, as "any place in which slop-pails, &c., are kept should have plenty of light and ventilation, all of which are here absent". The removal of the sink to the third floor at Q will not improve matters unless a separate skylight is inserted in the roof over; this alteration is not suggested by the Commissioners, nor is the cost included in the estimate

which accompanies their report. The suggestion of the Commissioners that light can be obtained through the new skylight or sash provided for the cistern-room over, does not commend itself to the sanitarian. The new sink must be of enamelled fire-clay, and must have a $1\frac{1}{2}$-inch lead waste-pipe with "a cast-lead syphon trap fitted with a brass cleansing screw" immediately under the sink. "This waste-pipe is to be carried down to the basement at the side of rain-water pipe B, fitted at the bottom with a brass thimble, and continued in a strong iron pipe with caulked-lead joints under the floor of the passage and pantry into the front area, where it delivers over a gully. The upper end of this pipe is to be carried up in the cistern-room and through the lead flat over, where it finishes about 12 inches above the flat, the end being fitted with a copper-wire cover. The trap must be provided with an anti-syphonage pipe connected with the ventilating pipe. . . . The whole of the floor of this closet should be covered with 7-lb. lead, close copper-nailed round and across."

The stone sink at R, which is fitted with a bell-trap, should be replaced with a glazed-stoneware sink, fitted with a 2-inch lead waste and syphon-trap, and $1\frac{1}{2}$-inch lead anti-syphonage pipe, as shown in fig. 201, page 310, vol. i.

The lead-lined sink S in the servants' hall has a 1-inch waste passing into a 6-inch D-trap and thence into the drain. In place of this a deep glazed-stoneware sink should be fixed, and fitted with a brass plug-waste, and with a $1\frac{1}{4}$-inch lead waste-pipe and trap, and a 1-inch anti-syphonage pipe.

As **the sink T in the pantry** is chiefly used for washing glass, it should be lined with lead, and the adjacent draining-board may be covered with pewter. The sink should have two compartments, and be fitted with waste-pipe, trap, and anti-syphonage pipe as the sink S.

The waste-pipe from **the lead-lined sink U** in the housekeeper's room is disconnected from the drain, but is not trapped. A new small enamelled-fire-clay sink should be provided, with a $1\frac{1}{4}$-inch waste-pipe trapped as above, and carried to the gully H H.

The bath-room on the second floor has neither direct light nor ventilation. These defects are very cleverly remedied by cutting out part of the floor of the box-room over, and forming a shaft for light and air up to the new skylight in the lead flat. The space occupied by the old Bramah closet L is added to the bath-room. The old bath is of painted zinc, and inclosed with a mahogany casing. Under the bath is a lead safe with a sunk well, from which the waste water passes through a small D-trap into the soil-pipe P. The waste and over-flow of the bath deliver over the trap in the well of the safe. The recommendations include a new cast-iron bath with a mahogany top, but without wood

inclosure, and a new overflow from the safe carried through the external wall, or, if this cannot be done on account of the position of the floor-joists, connected with the rain-water pipe B. The bath-waste should be of lead, $1\frac{1}{2}$ inches in diameter, "continued under the floor of the servants' hall into a strong 2-inch cast-iron drain-pipe laid on 6 inches of concrete, to deliver over the gully X in the middle area".

The hot-water service is on the tank-system, and the Commissioners recommend that the tank be removed and a 50-gallon galvanized-iron cylinder be fixed instead at I I, close to the kitchen-range. The cylinder should be incased with asbestos to prevent loss of heat, the inspection-plate, however, being left free. The old boiler is not provided with a safety-valve. The following improvements are suggested:—"Carry up a short $1\frac{1}{4}$-inch pipe from the top of the cylinder, and fix on the end of same a dead-weight safety-valve. In this position the valve will be more accessible, and less liable to become corroded with dirt than if placed in the chimney; or should the valve be taken directly off the boiler, which most authorities insist upon, it should be brought through the chimney-breast. When the boiler is charged, lift the weight of valve, that this pipe from the boiler may be charged also, or steam will generate in it." The Commissioners also draw attention to the necessity for removing the incrustation from kitchen boilers at regular intervals.

The old drains, shown on the basement plan, are badly designed, the curves preventing inspection, and rendering the clearing of the drains in case of stoppage an impossible task; the curves also check the flow of sewage, and thus tend to allow deposits to take place. The main drain is 9 inches in diameter, and therefore much too large; the branches are formed with 6-inch and 4-inch pipes, laid without concrete beds, and have sunk in several places, causing leakage. The traps are of bad design; bell-traps occur at W, Y, and I, a D-trap at X, and brick-built traps at E and Z. The drain from the latter trap to the sewer is of brick, and 14 inches in diameter; the pipe from the adjacent W.C. is connected with this drain on the *sewer* side of the trap. It will be noticed that no provision is made for ventilating the drains, the result being the accumulation of foul air throughout the system and the consequent pollution of the air in the house.

The new drain from the inspection-chamber Z to the disconnecting chamber C C must be of cast-iron 4 inches in diameter, and coated internally with Angus Smith's solution; the strength of the pipe is vaguely described as "stout". The branch-drains are to be of London glazed-stoneware pipes. All drains must be laid on a 6-inch bed of cement concrete, and covered with concrete after being

tested; the bed of concrete is designed to prevent settlement of the drain, and the covering to prevent fracture and (in the case of the iron pipe) corrosion. Trapped gullies must be fixed in the new area at A A, in the middle of the central area at X, another in the same area at Y to receive the waste from the sink S, a fourth in the front area at H H to receive the waste from the sink U and from the boiler W, another at D D to drain the front area, and one at F F to receive the water from the sink T and the rain-water pipes A and B. A flushing gully, similar to that shown in fig. 389, page 473, vol. i., must be fixed in the central area to receive the waste from the scullery sink R, the gully to be flushed by means of a 30-gallon automatic galvanized-iron flushing-tank, fixed on iron brackets in the kitchen, about 8 feet from the ground.

The disconnecting chamber C C must have a concrete bottom with white-glazed channels, syphon trap with 4-inch contracted inlet and 5-inch outlet, stock-brick sides in cement mortar, galvanized cast-iron air-tight frame and cover, and a 4-inch air-inlet at E E, having a pipe carried up in a chase cut in the front wall of the area, and finished with a galvanized box and grating. The inspection-chamber Z is similar to the chamber C C, except that it has neither a trap nor an air-inlet. Similar chambers are now usually rendered with cement mortar, but in many cases the drains are continued through the chambers, bolted covers being provided for access.

On the completion of the work the drains and manholes should be tested with water, and "after the manhole-covers have been bedded down in Russian tallow, the soil-pipes and drains should be finally tested by means of smoke or chemicals". It is better to test the soil-pipes also with water.

A detailed estimate of the cost of improving the water-service and sanitary arrangements in the house was included in the Report of the Commissioners, and a summary of the figures is given in Table XXXVI., page 392.

In **Plate XXVI.** a house of the same size as that just considered is shown, the left-hand drawings giving the original arrangements, and the right-hand showing the alterations. On account of the better position of the water-closets, &c., the cost of bringing this house up to the modern standard is only £377, 10*s.* 2*d.*, that is to say, £240, 13*s.* 8*d.* less than in the previous case.

The alterations in this house recommended by the Commissioners are briefly as follows, the references being to the letters on the Plate:—

A. This rain-water pipe is satisfactorily disconnected over a gully in the front area, and does not require alteration.

B. This rain-water pipe discharges over a gully in the cupboard near the door of the servants' hall, a bad position; the gutter on the lead flat must be altered

TABLE XXXVI.

ESTIMATED COST OF IMPROVING THE WATER-SERVICE AND SANITARY ARRANGEMENTS OF A TERRACE-HOUSE.[1]

	£	s.	d.
Work in connection with rain-water pipes, and drains therefrom,	18	10	8
" " " water-service and cisterns,[2]	81	12	11
" " " water-closets,[3]	259	2	6
" " " sinks, ...	52	13	3
" " " bath,[4]	51	9	4
" " " hot water, ...	36	3	9
New drains, ...	91	15	5
New inspection-chambers, ...	26	16	0
Cutting and making good generally, ...	20	0	0
	638	3	10
Credit value of old materials, ...	20	0	0
Net cost, ...	£618	3	10

so that the pipe can be taken outside the building, and made to empty on the flat below.

C. This rain-water pipe is only $2\frac{1}{2}$ inches in diameter, and should be replaced by a new $3\frac{1}{2}$-inch galvanized cast-iron pipe, the larger pipe being necessitated by the additional water which the alteration of the pipe B has diverted in this direction.

D. This rain-water pipe is 4 inches in diameter and disconnected at the foot; it is recommended that the gully be removed, and the pipe connected directly with the drain, so that it will serve as a ventilating shaft for the portion of the new drain between the back and central areas. The use of rain-water pipes as ventilating shafts is not, however, advisable, even when, as in this case, the drain is short, and does not receive anything of a very foul character.

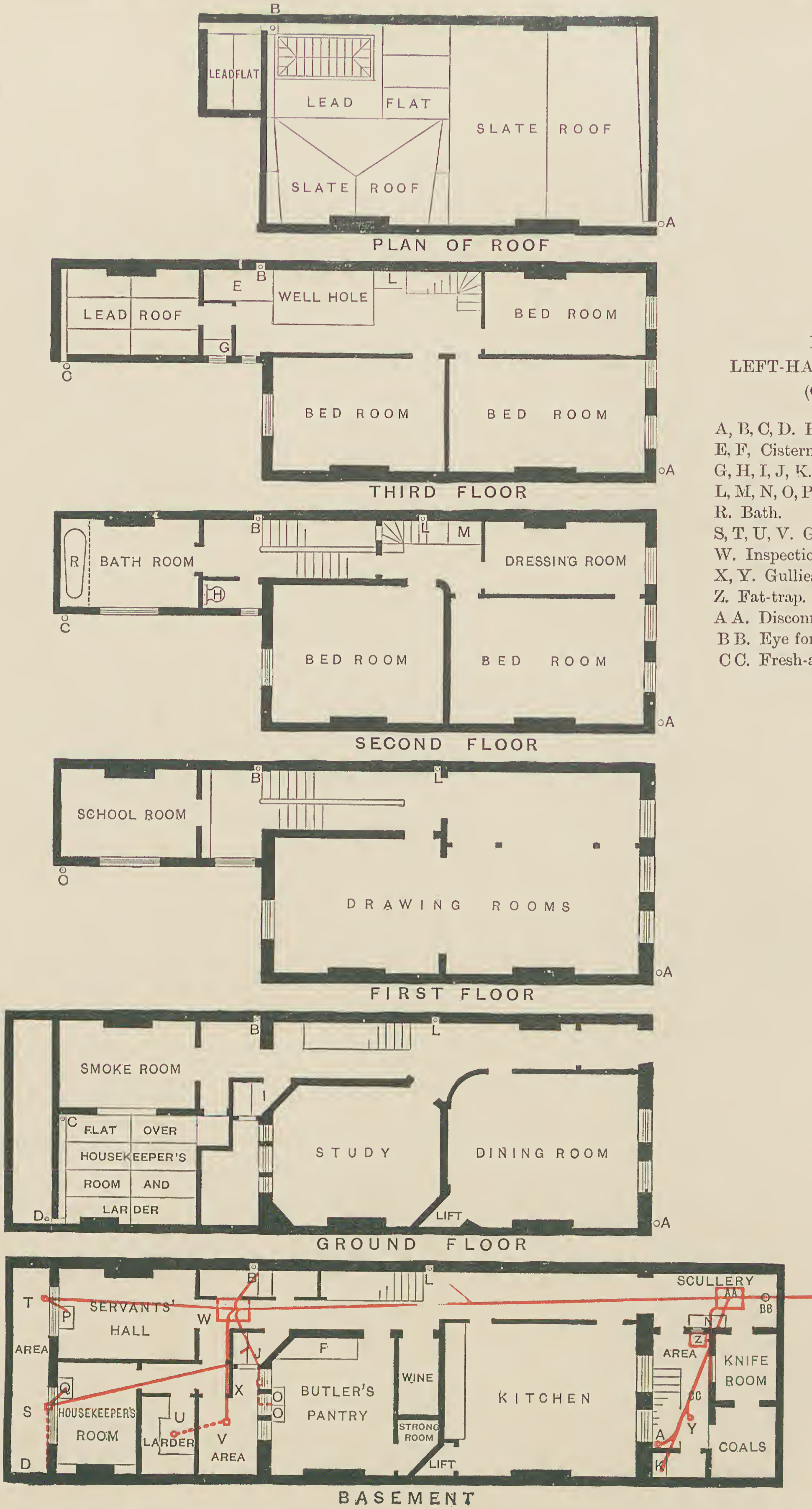
E. This is a lead-lined wood cistern, holding about 400 gallons, and supplying all the fittings in the house, with the exception of the sinks O, P, and Q, and the W.C. marked J. The recommendations of the Commissioners include the construction of a louvred window in the external wall above the lead flat over the bath-room,—this window is not shown on the corrected plan;—the alteration of the W.C. partition so that the W.C. may be effectually separated from the

[1] See Plate XXV.

[2] This includes £25 for forming the dormer in the roof to inclose the cisterns.

[3] This includes £18, 10*s.* for forming the new water-closet room J, £27 for the new W.C. room K, £19, 19*s.* for white glazed wall-tiles, £12, 10*s.* for the new W.C. room M, and £80 for removing the sink R and closet N, cutting away the lead-flat over to form open area, lining the area with white glazed tiles, cutting the new doorway into the kitchen, and building the walls to form new larder and scullery.

[4] This includes £22, 10*s.* for the new skylight, and shaft for light and air.



OLD ARRANGEMENTS.

REFERENCES TO
LEFT-HAND SECTION OF PLATE.
(OLD ARRANGEMENTS.)

A, B, C, D. Rainwater-pipes.
E, F, Cisterns.
G, H, I, J, K. Water-closets.
L, M, N, O, P, Q. Sinks and Waste-pipes.
R. Bath.
S, T, U, V. Gullies.
W. Inspection-chamber.
X, Y. Gullies.
Z. Fat-trap.
A A. Disconnecting Chamber.
B B. Eye for testing Drain.
C C. Fresh-air Inlet.

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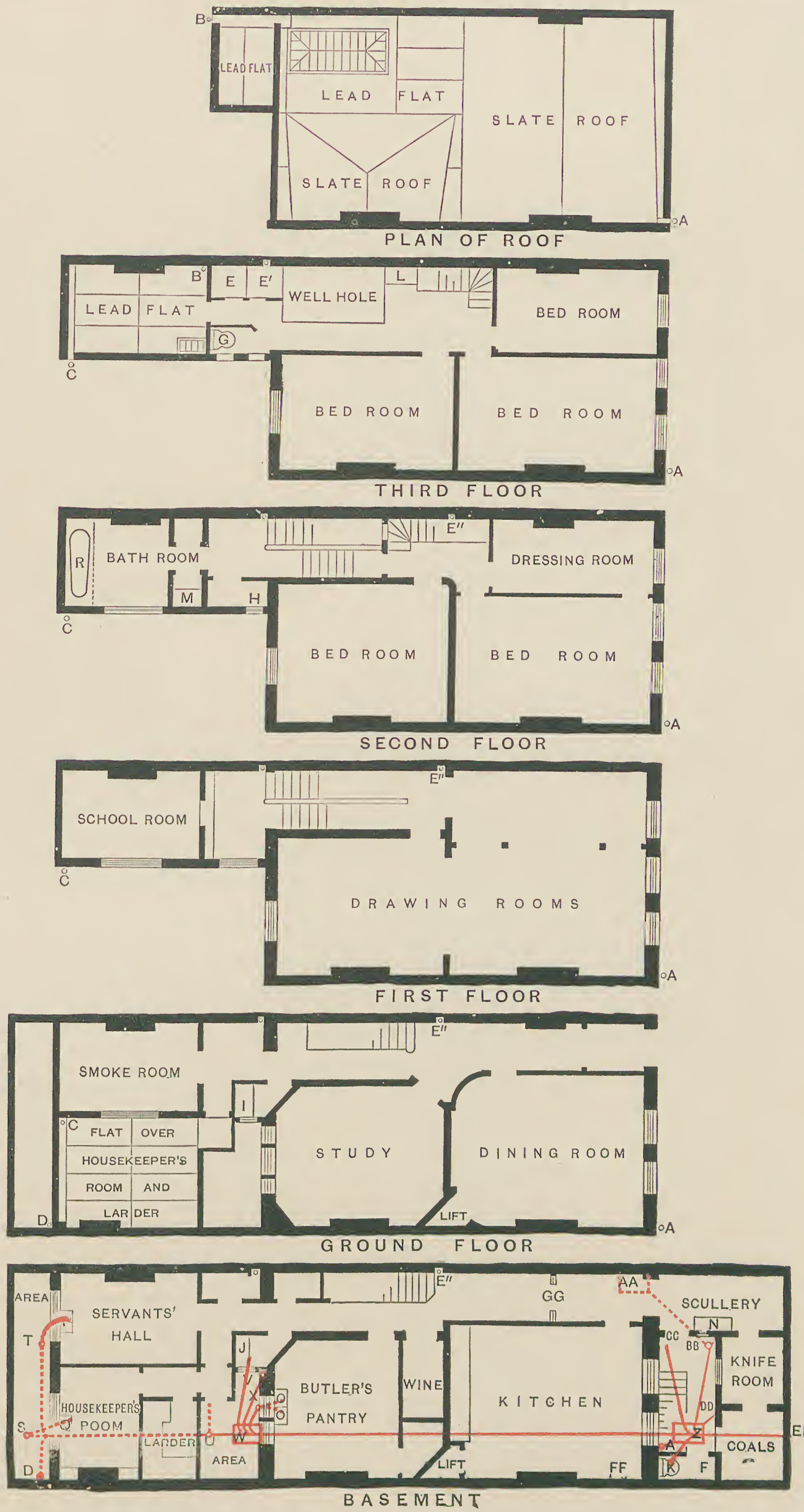
SANITARY ARRANGEMEN

REFERENCES TO RIGHT-HAND SECTION OF PLATE.
(NEW ARRANGEMENTS.)

A, B, C, D. Rainwater-pipes.
E. Lead-lined Cistern.
E'. Galvanized-iron Cistern.
E''. Down service from Cistern E'; all rising mains in same casing.
G, H, I, J, K. Water-closets.
L. Sink removed.
M. Sink (Housemaid's) into U.
N. Sink (Scullery) into E B.
O. Sink (Pantry) into X.
P. Sink (Servants' Hall) into T.
Q. Sink (Housekeeper's) into S.
R. Bath into U.
S, T, U. Gullies.
V. Soil and ventilating Pipe.
W. Inspection-chamber.
X. Gully.
Z. Disconnecting Chamber.
A A. Flushing Tank.
B B. Flushing Gully.
C C. Gully.
D D. Fresh-air Inlet.
E E. Eye for testing Drain.
F F. Hot-water Cylinder.
G G. Swing Door.



NEW ARRANGEMENTS.

OF TERRACE HOUSE, No. 2.

cistern; the division of the cistern into two parts by a lead-covered wood partition; the fixing of a galvanized-iron cistern E′ in one compartment; and the rearrangement of the service-pipes in such a way that the lead-lined cistern E supplies only the water-closets G, H, I, and J, and the new cistern E′ supplies the hot-water system, bath, lavatories, and sinks. The overflows from the cisterns must discharge on to the lead flat over the bath-room. A new $\frac{3}{4}$-inch main service-pipe must be laid to the cisterns, with a high-pressure screw-down gun-metal stop-cock in the scullery. The service-pipe from the new cistern must be $1\frac{1}{4}$ inches in diameter, and a $1\frac{1}{4}$-inch stop-cock must be fixed immediately under the cistern.

F. The zinc-lined cistern in the butler's pantry is no longer required, and must be removed.

G. The W.C.-room must be detached from the cistern by a new partition plastered down to the floor on both sides. The W.C. itself is a wash-out apparatus with defective joints, and must be removed; a new wash-down closet with flushing rim must be fixed.

H. This is an inferior valve-closet; the Commissioners recommend that it be removed, and a new inclosed white earthenware pedestal valve-closet be fixed in its place, as shown in fig. 696. The floor and walls should be lined with tiles.

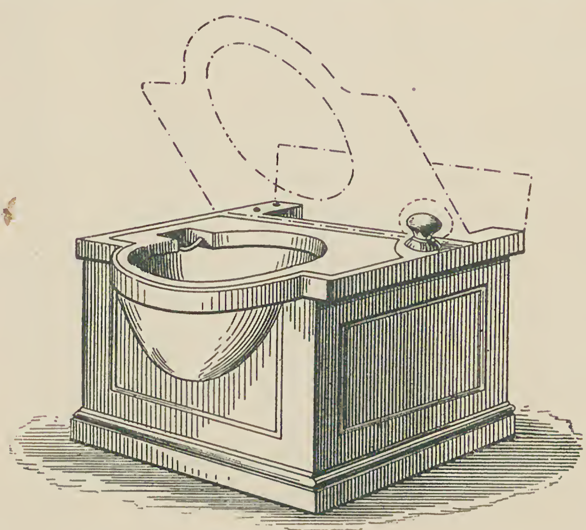


Fig. 696.—View of Inclosed White Earthenware Valve-closet.

I. This is "a side-outlet closet with a weighted rubber-lined plunger attached to the handle and a supply-valve under the seat". As explained in the Section on "Sanitary Fittings", plunger-closets are now considered very unsatisfactory at the best; in this case the trap is cracked, and no course remains but to provide a new closet. The Commissioners recommend the use of a wash-down pedestal closet.

J. This is a wash-down pedestal closet, but is defective in having the outgo of the S-trap under the pedestal, as it is almost impossible to make a perfect joint in such a position. This closet is shown in fig. 697. The outgo of a closet-trap should invariably be above the floor, as shown in figs. 293 and 294, page 391, vol. i.

K. Instead of this wash-out closet, a wash-down pedestal-closet must be fixed, care being taken to select one without an opening for an anti-syphonage pipe, as it is difficult to plug the hole so as to be permanently satisfactory.

The old soil-pipe serving the closets G, H, I, and J was a 4-inch seamed-lead pipe, carried down inside the building, and connected with the drain at the bottom. A 2-inch ventilating pipe was continued to about 2 feet above the parapet of the roof. "When a pailful of water was thrown down closet G, the water in the trap of closet H was syphoned out below the seal." The new soil-pipe must be $3\frac{1}{2}$ inches in diameter, of drawn lead, weighing 10 lbs. per lineal foot, and secured to the external wall with three pairs of "stout" cast-lead tacks to each 10-foot length of pipe. The pipe must be continued about 5 feet above the parapet, and finished "with a perforated lead cap with copper-wire guard". A brass thimble must be wiped to the soil-pipe at the bottom, so that a satisfactory connection can be made with the iron drain. A 2-inch anti-syphonage pipe must be taken, either from the iron branch of the lowest closet J, or from the anti-syphonage arm of this closet, and carried up to about 3 feet above the closet G, where it must be connected with the soil-pipe; the trap of each closet must be ventilated into this pipe by a short branch-pipe.

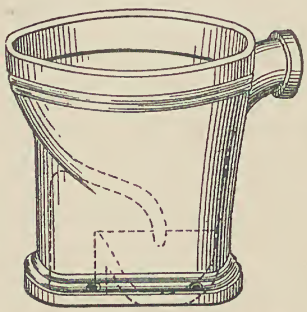


Fig. 697.—View of Defective Wash-down Pedestal-closet.

L. This lead-lined housemaid's sink is in an exposed position, and its waste is connected directly with the drain and is unventilated. The fitting and pipes must be entirely removed.

M. This sink also must be removed, and a new sink-room formed out of part of the bath-room, a skylight being made in the lead flat over for light and ventilation. The new sink must be of enamelled fire-clay, fitted with a $1\frac{1}{2}$-inch drawn-lead S-trap and $1\frac{1}{2}$-inch lead waste-pipe connected at the foot (by means of a brass thimble) with the branch-drain discharging into the disconnected gully U. The pipe must be continued as a ventilating pipe to about 2 feet above the parapet, and an anti-syphonage pipe must be taken from the trap of the sink into the ventilating pipe. The floor of the room should be covered with 7-lb. lead, copper-nailed.

N. The stone sink N must be replaced with one of glazed stoneware, fitted with a 2-inch trap and waste made to discharge into the new flushing gully B B in the front area; this gully will be flushed by means of a 30-gallon automatic flushing tank fixed on brackets in the adjacent passage. The new partition and door at G G are intended to keep back the smells from the kitchen and scullery.

O. Reline this sink with 6-lb. lead, ventilate the traps, and extend the waste-pipes so as to discharge over the altered gully X. The Commissioners recommend the removal of the adjacent filter, as "a neglected filter is infinitely worse than none at all".

P. This sink must be treated as the last, the waste being made to discharge over the gully T.

Q. Instead of the sink Q, fix an enamelled fire-clay sink, with $1\frac{1}{4}$-inch trapped waste-pipe discharging into the gully S.

R. The old zinc bath with wood casing must be removed to make way for an enamelled cast-iron bath, which must be fitted with a $1\frac{1}{2}$-inch trap and waste-pipe carried into the waste from the sink M; the trap of the bath must be ventilated by a pipe connected with the anti-syphonage pipe from the same sink.

The hot-water service must be altered to the cylinder-system, as in the previous example.

S, T, and U, on the corrected plan, are new gullies to receive the discharges of the various waste-pipes.

V. This represents, on the corrected plan, the new soil-pipe and drain-ventilating pipe.

The drains should be relaid as shown on the corrected plan, in order that the inspection-chamber W and the disconnecting chamber Z may be in the areas, instead of under the floor of the house, and to avoid the long branches, &c. The new drain from chamber to chamber must be of 4-inch "heavy" cast-iron pipes coated with Angus Smith's solution; the other drains may be of stoneware pipes laid on concrete.

The estimated cost of the alterations to this house is £377, 10*s.* 2*d.*

The third and last example cited by the Commissioners is **a suburban villa,** shown in fig. 698.

The rain-water pipes, Nos. 1, 2, and 4, must be disconnected to discharge over the trapped gullies E, D, and A, and that marked No. 3 should, it is said, be connected directly with the side inlet of the gully C by means of 4-inch drain-pipes. This is done in order to avoid a long length of unventilated drain, but the same object can be attained by fixing a shoe at the foot of the rain-water pipe, and an untrapped grate in the drain under it; this branch will be cut off from the remainder of the drainage system by the trapped gully C, and will itself be open to the air at both ends.

The water-service arrangements are satisfactory, except that the cistern should be provided with a lid, and a $\frac{3}{4}$-inch dead-weight safety-valve should

be fixed on a short length of steam-pipe carried from the top of the kitchen boiler.

The water-closets are defective. That on the first floor is a valve-closet with cast-lead trap and short length of soil-pipe, the latter connected, by means of a red-lead joint, with the branch of a 4-inch cast-iron rain-water pipe; to

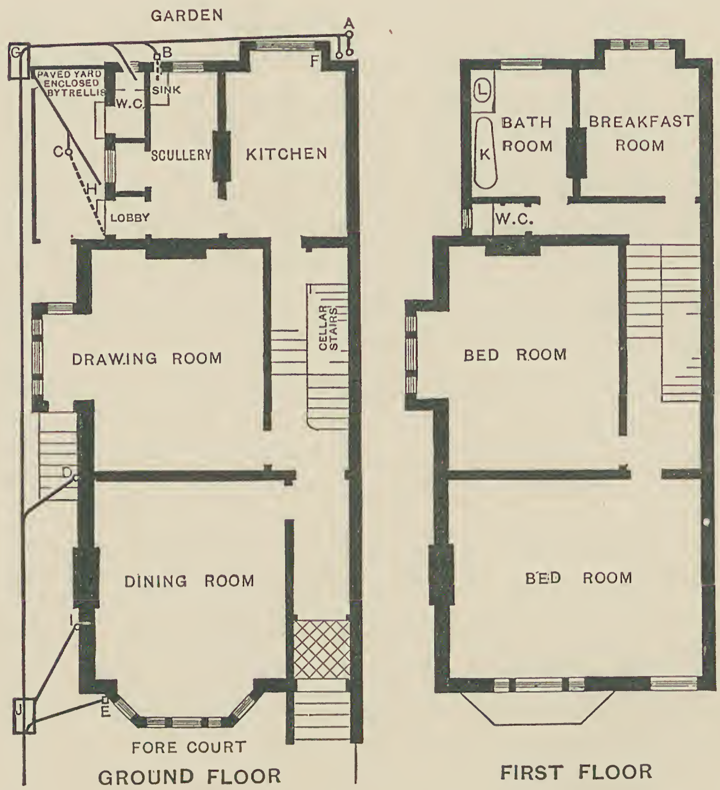


Fig. 698.—Corrected Sanitary Arrangements of a Suburban Villa.

make matters worse, the joint is in the middle of the wall, as shown at A in fig. 699, and the branch is angular instead of curved. The recommendations of the Commissioners include the fixing of a pedestal-closet with slop-top and lead trap; $3\frac{1}{2}$-inch branch-pipe of 10-lb. lead with brass thimble at the outer end, so that a caulked joint can be made between it and the branch of the new cast-iron soil-pipe; $3\frac{1}{2}$-inch cast-iron soil-pipe H weighing not less than 56 lbs. per 6-foot length, with caulked joints, and carried up about 5 feet above the gutter or 1 foot above the ridge; 2-inch lead anti-syphonage pipe; 3-gallon silent cistern with $1\frac{1}{4}$-inch flush-pipe; self-raising mahogany seat; and lead safe with $1\frac{1}{4}$-inch overflow through the external wall. Remove the wash-out closet in the yard

W.C., and fix in its place a wash-down closet with S-trap, supported on a brick pedestal, and cement the floor and walls around the apparatus.

The lavatory-basin L must be fitted with a $1\frac{1}{2}$-inch drawn-lead syphon trap, and $1\frac{1}{4}$-inch anti-syphonage pipe carried through the wall and finished with crossed copper wires.

The bath K is of cast-iron without inclosure. It requires a $1\frac{1}{4}$-inch "running" trap, and $1\frac{1}{4}$-inch waste-pipe carried down to the gully B and up (as a ventilating pipe) through the projecting eaves, where it must be flashed around; a 1-inch anti-syphonage pipe must be taken from the trap into this ventilating pipe.

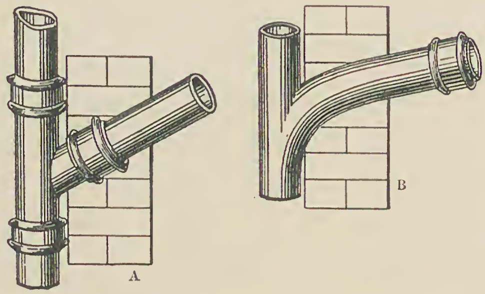


Fig. 699.—A, Faulty; B, Satisfactory Connection of Closet-outgo with Soil-pipe.

The scullery sink is of stone, and must, it is said, have a $2\frac{1}{2}$-inch drawn-lead S-trap, $2\frac{1}{2}$-inch lead waste discharging over the gully B, and $1\frac{1}{2}$-inch anti-syphonage pipe. The sizes of the trap and waste are unnecessarily large.

The ventilation of the drains is secured by the air-inlet at I and the extract-pipe at F, the latter being of cast-iron similar to the soil-pipe and carried about 4 feet through the roof. The inlet will be carried only about 2 feet above the ground, and fitted with a grating at the top.

The drains must be of 6-inch London-made glazed-stoneware pipes with 4-inch branches, all surrounded with concrete. A disconnecting chamber must be built at J, measuring 3 feet by 2 feet 3 inches inside, of 9-inch brickwork in cement, with concrete bottom, glazed channel and junction (the channel to fall 6 inches in the length of the chamber), syphon trap, and galvanized-iron cover. The chamber at G will be similar, but without trap and air-inlet. The gullies A, D, and E must have half-channel side-inlets and galvanized-wire covers, and the gully B must have "an egg-shaped bottom, with back-inlet for scullery-sink waste and a side-inlet for waste of bath". The drains and soil-pipe must be tested as in the first example. For a house of this size a main drain 4 inches in diameter will be ample, and three-quarter-round channels in the manholes are better than half-round.

The estimated cost of carrying out the work in this villa is £117, 17*s.* 5*d.*

CHAPTER V.

EXTERNAL SANITARY DEFECTS AND LIGHTNING-CONDUCTORS.

Many houses are rendered unhealthy by the proximity of insanitary privies, middens, cesspools, &c., and a few words must be included respecting these.

Privies are almost invariably nuisances, and the ordinary by-law to the effect that no privy shall be constructed within 6 feet of a house is entirely inadequate to meet the needs of the case. The rule of the Education Department, that "*cesspits and privies should only be used where unavoidable, and should be at a distance of at least 20 feet from the school*", is one which ought to be applied in connection with houses wherever possible. The use of privies in the vicinity of wells is most dangerous.

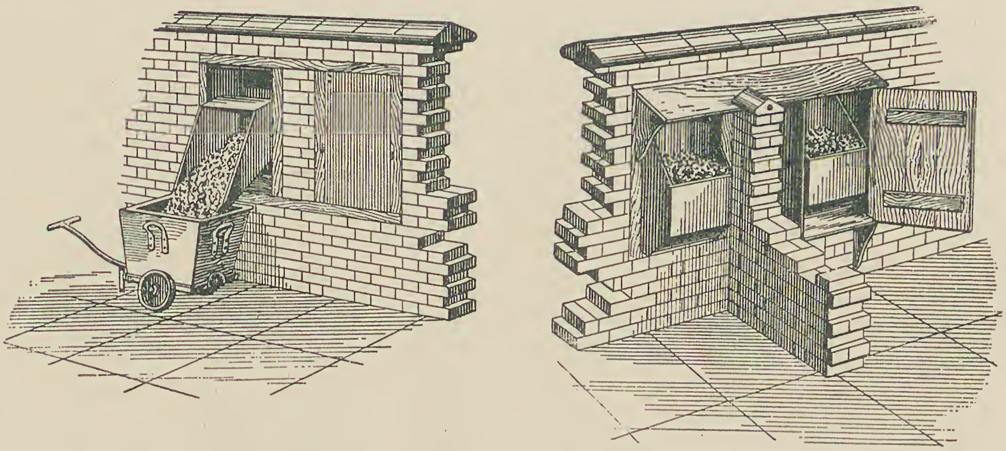
To improve an old midden-privy, it is advisable to excavate the soil under and around it and fill the space with hard, clean rubbish, to form the floor of the privy with cement concrete laid with a good fall to the door, to cement the walls under the seat as well as the floor, to make the front of the seat to open for convenience in removing the pail, to provide a soil-pail of wood or galvanized-iron, and to insert in the walls of the privy one or more air-grates. If an automatic arrangement be provided for supplying dry earth or fine ashes to the fæces, so much the better.

The large open ash-pit, which used to be so common, is now fortunately giving place to smaller and cleanlier receptacles. Many codes of building-regulations specify that the total capacity of the ash-pit shall not exceed 6 cubic feet. This may be built of brickwork 9 inches thick, but it is much better to have a galvanized-iron movable receptacle, which must be provided with a lid. Care must be taken to put nothing into the dust-bin which can be burnt; vegetable and animal garbage, putrefying in the bin, will pollute the air in the neighbourhood of the house.

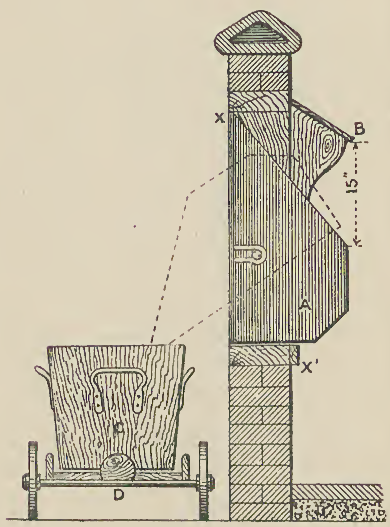
A very convenient ash-bin, adapted for use in towns where the house-yards abut upon back streets, is made of galvanized-steel plates, and is hung on pivots in the yard wall, as shown in fig. 700. By its use the entrance of the scavengers into the house-yard is prevented, and the refuse is more easily removed.

Cesspools are often seriously defective. Many are not, and never were, water-tight. Some Sanitary Authorities, in spite of their by-laws to the contrary, allow new soak-away cesspools of this kind to be constructed,

so that the cost of emptying them will not fall on the rates. The question whether such a cesspool may be continued in use is often one of considerable



difficulty, but it ought certainly to be abandoned if it is within 20 or 30 yards of any part of the house or within 50 yards of a well (at or near the same level) used for domestic supply. Every cesspool ought to be ventilated by a heavy iron or drawn-lead pipe with air-tight joints, continued upwards to a height of 10 feet above the ground and fixed to a wall or other firm support. A manhole fitted with an air-tight cover is necessary for access, and another manhole ought to be built over the drain near the cesspool, and provided with an intercepting trap to prevent foul air from the cesspool from passing into the drain. This manhole must have an opening for air to promote the ventilation of the drainage system.



Section.

Fig. 700.—Quine's Sanitary Ash-bin.

LIGHTNING-CONDUCTORS.

It is now just about a hundred and fifty years since **Benjamin Franklin,** as related in his delightful autobiography, wrote a paper "on the sameness of lightning with electricity", and thereby grievously offended the Abbé Nollet, who, being "Preceptor in Natural Philosophy to the Royal Family" of France, could not brook a theory in contradiction of his own. The Abbé's opposition was of no avail, and Franklin's discovery was not long without practical results; if electricity could be brought from the clouds by means of a kite, why might not permanent conductors be attached to buildings for the purpose of conveying atmospheric electricity safely to earth, thereby preventing the sudden and terrible havoc so frequently wrought by lightning? Franklin acted on the thought, and the first lightning-conductor was that fixed on his own house in Philadelphia in 1752.

Fig. 701.—Terminal for Lightning-conductor.

The Lightning-Rod Conference in 1882 formulated a number of rules for the erection of lightning-rods, but the protection against lightning afforded by rods erected in accordance with these rules proved to be inadequate, and in 1900 a paper read by Mr. Killingworth Hedges, M.Inst.C.E., before the Royal Institute of British Architects, led to the formation of a committee of architects, engineers, and others (including Sir Oliver Lodge) for the purpose of investigating the subject more thoroughly.

This committee, known as the **Lightning-Research Committee,** pursued its investigations for four years, and in 1905 issued a valuable report, containing practical suggestions for protecting buildings more fully against damage by lightning. Up to this time the theory commonly held was Franklin's theory, that the excess of electricity in the air could be drained away to the earth by means of a few vertical rods, and could thus be prevented from damaging the buildings to which the rods were attached. Sir Oliver Lodge, in the Preface to the Committee's Report, pointed out that this theory took into account the quantity only, and not the energy, of the electricity. "Like an avalanche," he wrote, "it will not take the easiest path provided for it, as if it were a trickling stream, but will crash

through obstacles and make its own path; . . . hence no one path can be said to protect others, and the only way to protect a building with absolute completeness is to enclose it wholly in metal; an invisible cage or framework, however, descending vertically down its salient features, with the utilization of any metal in its construction, suffices for all practical purposes, unless the building is a powder magazine". In the opinion of the committee the methods of construction advocated by the lightning-rod conference "still hold good" in the main, but some important modifications were suggested, and special stress was laid on the necessity for keeping the earth-connection permanently moist.

In its simplest form a lightning-conductor consists of three parts: (1)

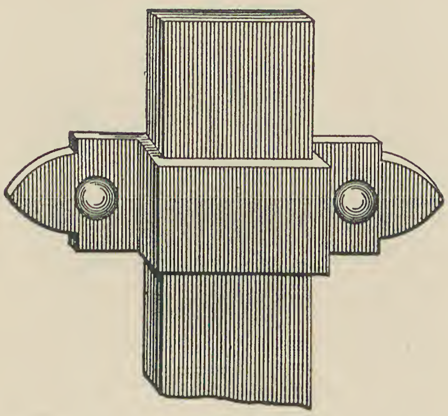


Fig. 702.—Copper-tape Lightning-conductor, 1 in. + ⅛ in.

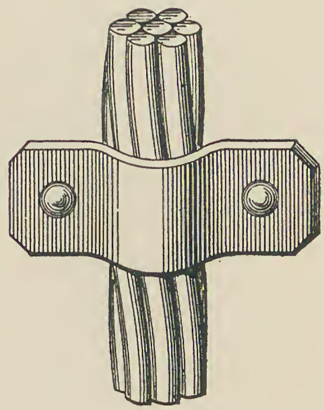


Fig. 703.—Half-inch Copper-rope Lightning-conductor, composed of 7 wires.

the terminal at the top, (2) the metal conductor or rod, and (3) the earth-connection at the bottom. Copper is the metal usually employed, but the fact that it is one of the best conductors of electricity is not now regarded as a point in its favour. In the words of Sir Oliver Lodge, "a lightning-conductor of perfect conductivity, if struck, would deal with the energy in far too rapid and sudden a manner, and the result would be equivalent to an explosion; a conductor of moderately high resistance, such as an iron wire, would get rid of it in a slower and therefore much safer and quieter manner; though with too thin a wire there may be a risk of fire". The great advantage of copper is its durability; if iron is used, it must be galvanized and periodically painted.

The terminal at the top of a lightning-conductor should be a solid rod, and should be fixed so as to stand clear above the highest part of the building; it must be provided with a number of solid "points", as in fig. 701, for receiving

the discharge of electricity. It is sometimes possible to utilize a metal vane or finial as a terminal, but great care must be taken in making the connection between it and the rod.

The conductor itself may be in the form of a tube, rod, rope, or tape, but the tape is now most commonly used. Ropes composed of several strands of copper wire, as shown in figs. 703 and 704, are, however, sometimes preferred, and can be obtained of great length. The rope with the larger wires (fig. 703) is the better of the two. For main conductors the weight must be not less than 6 oz. per foot if of copper, or $2\frac{1}{4}$ lb. per foot if of iron.

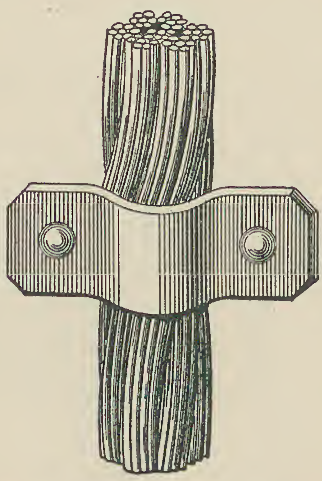


Fig. 704.—Half-inch Copper-rope Lightning-conductor, composed of 49 wires.

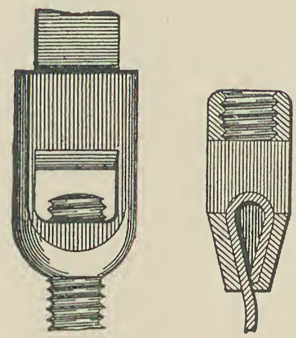


Fig. 705.—Elevation and Section of "the Lewis Link".

The conductor must be fixed to the building by means of suitable clips, as shown in figs. 702, 703, and 704, or by projecting holdfasts, and must be as straight as possible, all sharp bends being carefully avoided. Insulators were formerly placed between the conductor and the wall, but are never used now. The conductor should be in one length only where possible; if the building is lofty, it may be necessary to use two lengths, but the joint must be perfect, otherwise there will be danger. The connection with the terminal must also be perfect; an arrangement, known as "the Lewis link", is shown in fig. 705. This is designed for copper tapes; the end of the tape is bent into a loop and placed in the wedge-shaped socket in the lower part of the link; the end of the terminal rod is screwed down on to the tape. Scarfed and riveted joints are sometimes used, but whatever kind of joint is used, it ought to be protected from the air.

The lower end of the conductor is as important as any other part. What is required is a metallic surface of sufficient area to allow the electricity

to escape freely into the ground. Four methods may be adopted: (1) the conductor may be continued underground and properly connected to an iron main (preferably a water-main); (2) it may be connected to a copper or galvanized-iron plate, buried in earth, which is kept permanently moist by rainwater or other water; (3) a sufficient length of tape attached to the conductor may be buried as described above; and (4) a steel tube may be driven into moist ground and lengthened up to the surface, and the conductor may be continued down to the bottom of the tube, the space remaining in the tube being then filled with granulated charcoal. Sometimes the conductor is bifurcated, and the two ends are connected in two of the ways described; in this case the plate in (2) would be 3 feet square, giving a surface area (measured on both sides) of 18 square feet, and the tape in (3) would have the same superficial area. Cinders and coke are sometimes packed around the earth-plates and tapes, but charcoal is better, as it has no injurious effect on the metal.

For the adequate protection of a building a single conductor of the simple type just described is almost invariably insufficient. Two or more vertical conductors (according to the size of the building) are necessary, and these ought to be connected together horizontally. The pipes and other large masses of metal in the building must be connected to the conductors or be separately earthed. Iron soil-pipes connected to iron drains undoubtedly serve as lightning-conductors. The following suggestions, made by the Lightning-Research Committee, are of the greatest value:—

1. Two main lightning-rods, one on each side, should be provided, extending from the top of each tower, spire, or high chimney stack by the most direct course to earth.

2. Horizontal conductors should connect all the vertical rods (*a*) along the ridge, or any other suitable position on the roof; (*b*) at or near the ground line.

3. The upper horizontal conductor should be fitted with aigrettes or points at intervals of 20 or 30 feet.

4. Short vertical rods should be erected along minor pinnacles, and connected with the upper horizontal conductor.

5. All roof metals, such as finials, ridging, rainwater and ventilating pipes, metal cowls, lead flashing, gutters, &c., should be connected to the horizontal conductors.

6. All large masses of metal in the building should be connected to earth either directly or by means of the lower horizontal conductor.

7. Where roofs are partially or wholly metal-lined, they should be connected to earth by means of vertical rods at several points.

8. Gas pipes should be kept as far away as possible from the positions occupied by lightning conductors, and as an additional protection, the service mains to the gas meter should be metallically connected with house services leading from the meter.

Section XVII.

HOUSEHOLD FILTERS

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SECTION XVII.—HOUSEHOLD FILTERS.

An old saying of Dr. M'Adam, that "**domestic filters are a delusion and a snare**", although sweeping, is still very true, unless they are most carefully selected and periodically cleansed. The very presence of a filter leads to a false sense of security, which may be a fruitful source of danger. An instance illustrating this occurred in India, as recorded in *The British Medical Journal*, on December 26, 1896. An outbreak of typhoid fever was traced to aërated water as a cause. The water in the mains was free from typhoid bacilli, but after passing through a certain cistern was found to contain them. The cistern was emptied, and a small filter was found in it, which had been *in sitû* during a former temporary infection of the water with typhoid. Others like it had been removed, but this had been overlooked. It had been contaminated, and had preserved and possibly increased the infection, and had communicated it to the source from which the aërated water was manufactured, after all trace of infection had disappeared from the mains.

To gauge the purity of filtered water merely by the amount of **organic matter** present is misleading, though many testimonials given by analysts are based upon this test. The presence of organic matter is an indication of probable sewage or organic contamination, but is no guide to the number or quality of specific disease-organisms. Such testimonials, therefore, are useless as a guide to the choice of a germ-proof filter. Equally, of course, all testimonials given previous to the year 1880 are untrustworthy for the same reason.

The accepted definition of a filter is—An arrangement for separating the impurities from liquids, by passing these through a porous material. This is a satisfactory definition for general purposes, but for household filters something more is required. Not only must such a filter separate all impurities from the liquid; it must also not add any fresh impurities, either in suspenson or solution.

Filtration in Nature goes on constantly on an immense scale. Water, falling on the earth's surface in the form of rain, brings with it impurities in the form of solid particles and gases in solution or suspension. These impurities occur in a marked degree in the neighbourhood of large towns. The rain-water during its passage over or through the gathering-ground, carries all kinds of animal, vegetable, and mineral matters along with it. It sinks then deeper and passes

through various strata,—becoming, perhaps, still further impregnated with mineral matter,—and after being confined beneath some impermeable stratum, may eventually crop out on the surface as a spring. These outflow-points of deep springs are the taps of Nature's filters. The water from them is generally bright, sparkling, and clear. The original dulness of the water, and the debris which it held in suspension on the gathering-ground, are gone, having been separated during the passage through the various strata of sand, gravel, chalk, lias, &c. This mechanical straining, however, is only one function of an efficient filter.

In the spring-water, pleasant to the eye though it may be,—and generally to the palate also,—mineral, gaseous, and even vegetable matters may be present in solution or suspension, collected during its contact with strata rich in these ingredients. These matters, foreign to a pure water, may or may not be harmful if the water be drunk. Many waters thus impregnated are useful medicinally when properly applied, but taken continually may prove deleterious.

It is, however, vitally important that artificial filtering media should add no impurity to the water, and **a proper definition of a filter** would therefore be— An arrangement of porous material, passing through the interstices of which, a liquid, without gathering any fresh impurities, is freed from those which it originally possessed.

A glance at the history of household-filters shows that they are of ancient date. Those used by the Egyptians were made of earthenware or sandstone, egg-or-bowl-shaped vessels resting on a wooden frame. Through these the water percolated, and was collected in a receptacle below. Though the method of application differs greatly, yet we find this type of material employed as the filtering medium in the most modern and efficient filters (Pasteur, Berkefeld, &c.). Cistern-filters were made in the middle of the last century, a slab of lias being fitted as a false bottom, and the water drawn off by a tap below the filtering slab. The "Alcarazas" made in Spain are filters of porous biscuit-china. The patent-records show that Mrs. Johanna Hempel, in 1790, invented a filter consisting of a supported basin made of tobacco-pipe clay and coarse sand, hardened in a furnace. In 1791, Mr. James Peacock applied the ascending principle to filtration, and also used the method of cleansing the filter by a return stream. Vegetable charcoal was first used in 1802, animal charcoal in 1818, and carbon blocks in 1834. More recently, these and other materials have been used as filtering media, including stone, sand, gravel, clay, sulphur, preparations of iron, sponge, wood, silicated carbon, cane, capillary-threads, cloth, felt, horse-hair, skins, paper, and asbestos. These have all been used in various

forms, and inventors have expended much ingenuity in applying them in such a manner that the filtered water should be clear, sparkling, and pleasant.

In 1867, the **Lancet Sanitary Commission** reported upon the relative efficiency of most of the filters then in the market, and arrived at such conclusions as the then state of knowledge concerning water-impurities allowed. The points which the Commissioners set themselves to investigate were suggested by the fact that these filters were "advertised as doing something more than straining water from suspended matter"; they were "stated to free water from some of the matters dissolved in it".

These investigators had to rely for their results upon chemical or the coarser optical tests, the only ones then known. We know now that no chemical tests are sufficient for the pronouncement of a water as pure and fit for drinking purposes. Such tests can show that a certain water is not fit for drinking, and for this purpose they are useful; but a water, which in the fullest degree satisfies chemical tests, may nevertheless contain the most deadly germs of disease in considerable quantity. Although it had long been recognized that some contagious diseases (typhoid and cholera for example) were spread by the agency of drinking-water, yet it was not until the early eighties of this century, when the "germ theory" was propounded, and the microbes connected with various diseases were discovered, that it was known exactly what the pathogenic impurity was. This discovery, which marked an epoch in the history of medicine, affected every branch of that art, and the filter question as much as any.

Until this time three special conditions had been required of a filter, viz.:—

I. That it should remove macroscopic suspended matter from water.

II. That it should, to some extent at least, chemically alter the composition of water, *e.g.* remove or lessen hardness, extract from the water the metals in solution (iron, lead, &c.), and render organic matter less harmful by changing nitrites into nitrates.

III. That it should aërate a dead water, *e.g.* rain-water or boiled water.

To these three conditions a fourth has now to be added, vastly more difficult to fulfil and of equal or even greater importance, viz.:—

IV. That it should remove microscopic suspended matter, *including bacilli and other micro-organisms.*

It is true that the large proportion of **micro-organisms** are practically harmless, but as a filter is at best only a machine, and incapable of distinguishing the harmful from the innocent, it must be so designed as to free water from *all* germs, infective or otherwise. In a word, the filter must be "germ-proof".

For if harmless bacteria can find their way through, those of disease may do so also; as, for instance, the cholera bacillus, which is amongst the smallest.

A clear understanding of **the difference between the mechanical and organic passage of germs** through a filter is necessary. *Mechanical* or direct passage takes place almost immediately through a filter the pores of which are not sufficiently small, and such a filter is quite unreliable; *organic* passage occurs by growth of the bacteria in the interstices of the material, and complete passage is only effected after a certain lapse of time varying with the denseness of the material. Filters of this last class may be quite reliable against the specific germs of disease, owing to the fact that water—even the worst sample likely to be taken for drinking purposes—does not provide a medium in which such germs can grow; as the germs can neither pass mechanically nor grow through the pores, the filter serves its end.

During the years 1884–86 a long and complete series of trials of various kinds of filters was made, and the results were published at the **Medical Congress held in Berlin in 1886.**[1] About twenty varieties of filters were examined, new and old. Most of these were found, in a bacteriological sense, useless,—the germs passed directly through with the water. Not only this: in many cases the filtering material formed a *nidus*, or convenient breeding-place for the germs, so that, though at first the number in the filtrate was about the same as in the original water, yet in a short time the effluent contained a hundred or more times as many as the water which the filter was pretending to purify. The appended table, illustrating this point, is taken from *The Lancet*, 1894, vol. ii. p. 1058:—

Table XXXVII.

INCREASE OF GERMS IN WATER PASSED THROUGH FILTERS WHICH HAD BEEN IN USE 5 OR 6 MONTHS.[2]

Name of filter in continuous use for five or six months.	Average number of organisms per cubic centimetre before filtration.	Average number of organisms per cubic centimetre in filtrate.
Silicated carbon domestic filter,	30–40	800–1000
Atkins Admiralty filter,	40–50	600–800
Carbon-block table-filter (origin unknown),	20–30	5000–6000

A few of the filters—those in which clay or asbestos formed the filtering medium—were found to be germ-proof at first, but retained this quality only a

[1] *Tagblatt der Naturforscher-Versammlung*, Berlin, 1886, p. 323. [2] See also Table XXXIX., p. 416.

few days at most. By that time the germs had grown through the pores of the material, and showed themselves in the filtrate. There were other objections to these filters which rendered them practically worthless.

The results of investigation may be summed up thus:—

I. *Charcoal Filters*: quite useless—allow bacteria to pass at once, and form a breeding-ground where they multiply exceedingly.

II. *Spongy-iron Filters* do not keep bacteria back.

III. *Stone, Flint, Sand, Cloth, Sponge, and Paper Filters* of very various construction are not germ-proof even temporarily.

IV. *Asbestos Filters*: completely "germ-proof" for a time, but practically useless, owing to the difficulty and delicacy of manipulation required in renewing the material.

V *Chamberland-Pasteur Porcelain Filters*: quite germ-proof until the bacteria have grown through; supply of filtered water small.

The conclusions drawn from these very complete experiments were, *firstly*, that most filters allow micro-organisms to pass unhindered; *secondly*, that some porcelain and asbestos filters are germ-proof for a time, but after some continued use, of days or hours, cease to be so owing to the bacteria, by a process of growth and multiplication, finding their way through the pores of the material; and *thirdly*, that there is no filter which is lastingly germ-proof.

Many other and later investigations have emphasized these conclusions, and it has been recognized as a fact that there neither is nor can be such a thing as **a permanently "germ-proof" filter.** And how can it reasonably be expected? A watch will not go without winding, nor a kitchen-stove cook unless its flues are swept at intervals, nor an engine work satisfactorily unless oiled and kept clean. If then any filter is found to be "germ-proof" for a certain time, and it is also found that by proper periodical attention (whether by cleaning or sterilizing, or renewal of its medium) it is capable of continuing to supply water free from harmful germs, that is all that can be reasonably expected or that hygienic science can require.

Only **the workable usefulness** of such filters need then be considered, and this will depend upon—

I. The rate of delivery of the sterilized water.

II. The simplicity of construction and ease of manipulation for sterilizing and cleaning purposes.

III. The prime cost, and the cost of renewal of filtering material or parts liable to injury.

These three points embrace only mechanical details, upon which the ingen-

uity of the inventor has been exercised to a vast extent. Anyone making a few simple trials will be able to prove how far any particular filter efficiently fulfils these conditions. But with the prime question of "germ-tightness" it is different. Only someone whose mind and method have been trained to scientific accuracy of detail, and who has a well-appointed laboratory at his disposal, can pronounce finally upon this point.

The practical examination of filters in regard to the first three points is not difficult:—

I. **Rate of Delivery.** Fill the filter and open the delivery-tap, and note the time that the first pint takes to run; repeat this observation every hour, leaving the filter running all the while. The pint will take longer to run each hour, the time increasing quickly or slowly according as the water is less or more pure. An average of these hourly times must then be taken. Even when a water is fairly pure, any filter which is doing its work must in the very nature of things become stopped up. The rate will also vary with the pressure—whether the feeding-reservoir is full or partly empty,—and also with the capacity of the filter. A rapid delivery is suggestive of imperfect filtration, though slowness of filtration is not of necessity directly proportioned to the purity of the filtrate.

The flow must be sufficiently rapid to supply the wants of the household. The number of minutes required for the filtration of one pint of water by different filters will be found in Tables XXXVIII. and XL., pages 414 and 419.

II. **Simplicity of Construction.**

(*a*) *The case.* The compartment containing the filtering medium, and the reservoirs for unfiltered and filtered water, must be easily accessible for sterilizing purposes and for cleansing. There should be no unnecessary angles or corners, and every part of any reservoir should be easily seen when the filter is empty.

(*b*) *The filtering medium* should be easy to remove and to replace in its case. The cleaning has to be done often, and any unnecessary increase of labour would impair the usefulness of the filter as a domestic appliance. The filtering medium must be of such a nature that it can be readily sterilized by baking, boiling, or burning; it must not deteriorate in quality, nor be very liable to injury during sterilization.

(*c*) *The process of cleansing and sterilizing* must be capable of easy performance without the employment of skilled labour. The household filter will be tended by the domestic servant.

(*d*) *The fittings* of filters must be as inabsorbent as possible, preferably of metal which can be boiled. Where compressible material is necessary, india-

rubber should be used; this can be chemically sterilized and scrubbed. Corks are quite inadmissible anywhere in contact with the water. They are most often seen around the tubes in carbon-block filters, or around delivery-taps.

(*e*) *There must be no possibility of water passing from one reservoir to the other* without percolating through a sufficient thickness of the filtering medium.

III. **The prime cost** of the filter, and of parts requiring renewal, can be had from the makers' lists. It is necessary to consider the relative liability to injury of the various kinds of material when estimating the cost.

These three points can be settled without much difficulty, and there is still something more which every one can do for himself before handing over the investigation to scientists in laboratories. The old test of the capability of any filter to keep back very fine but visible suspended particles, may be applied. Before the "bacteriological era", this was the most searching test known. It consists in mixing with the water to be filtered a quantity of matter, in a state of minute subdivision, which will remain in suspension. These particles should not be found in the filtrate. If they are found, we may be sure that the filter is far from being germ-proof, and may be considered as useless for cleansing an infected water. Unfortunately the converse to this does not hold true, or it would simplify matters greatly. A filter may keep back all such suspended matters and yet not be germ-proof. The substances used for making the suspension are various, and include clay, garden-mould, gunpowder charcoal, ultramarine, and the minute fat-globules of milk stirred into and freely diluted with water.

Drs. Sims Woodhead and Cartwright Wood employed the three last-mentioned substances in testing non-pressure filters, in their "**Inquiry into the relative efficiency of water-filters** in the prevention of infective disease" (*British Medical Journal*, Nov. 10th, 1894, p. 1055). From actual and elaborate experiments they compiled the valuable table on page 414.

It will be gathered from the table how varied are the types of filters now or recently in use. The filtering-media tested include—to quote the report—"all the materials which have been used to any extent in the construction of filters".

I. **Carbon** in various forms, pure or compounded with some other chemical substance, as in the case of the silicated and manganous varieties:—

(*a*) In blocks, or in the powdered or granular form, used either separately or in combination.

(*b*) Charcoal in fine powder deposited on an asbestos cloth, or placed in the interior of a stone block.

Table XXXVIII.

TESTS OF NON-PRESSURE FILTERS BY Drs. WOODHEAD AND WOOD.

Name and Type of Filter.	Time (in minutes) required for Filtration of one Pint of Water.	Presence or Absence of Carbon in Filtrate.	Presence or Absence of Ultramarine in Filtrate.	Presence or Absence of Fat-globules of Milk in Filtrate.	Percentage of Organisms per c.c. allowed to pass into Filtrate.
Silicated carbon table filter (glass), ...	68	0	+ +	+ + +	7½
,, Ascension table filter (glass),..	120	0	+	+ + +	16
,, pocket filter, ...	N.R.	0	+ (?)	+ + +	N.R.
Doulton's pint table filter (solid block), ...	27	0	+	+ + +	26
,, pint table filter (solid block and granular carbon), ...	18	0	+	+ + +	13
,, carbon bottle filter, ...	13	0	0 (?)	+ + +	17
,, natural porous stone bottle filter, ...	15	0	0 (?)	+ +	31
,, pocket filter, ...	N.R.	0	+	+ + +	N.R.
Maignen's domestic *Filtre Rapide*, ...	4	0	0	+ +	0 (?)*
,, table *Filtre Rapide* (glass), ...	32	0	0	+ +	4
Atkin's Admiralty filter (No. 1), ...	5	0	+ +	+ + +	20
,, pocket filter, ...	N.R.	0	+	+ + +	N.R.
Asbestos filter, ...	6	0	0	+ +	7½
Fr. Lipscombe & Co.'s new patent cylinder filter,	23	0	+ +	+ + +	60
,, ,, table filter (solid block),..	30	0	+	+ +	45
,, ,, table filter (powdered and granular charcoal),	7	0	+ +	+ + +	30
,, ,, table filter (solid carbon block), ...	16	0	+	+ +	25
Spencer's magnetic domestic filter, ...	9	+	+ +	+ + +	15
Spongy-iron table filter (glass), ...	14	0	0†	+ + +	6
,, ,, (porcelain), ...	17	0	0†	+ + +	10
Morris's 2-gallon domestic filter, ...	2½	0	+ + +	+ +	12
Cheavin's Idiocathartes domestic filter, ...	¾	+	+ + +	+ + +	57½
Crown Filter Co.'s table filter (quart), ...	3	0	+	+ + +	28
Barston's table filter (quart), ...	35	0	+	+ +	27
Alcarazas domestic filter (No. 1), ...	57	0	0	+	0 (?)*
Slack & Brownlow's compressed charcoal domestic filter, ...	1	0	+ +	+ + +	26½
Wittmann's charcoal vase table filter, ...	10	0	0	0‡	0 (?)*
Defries & Son's carbon block glass table filter,	19½	0	+ +	+ + +	23
Pasteur - Chamberland filter (single candle, style F), ...	420	0	0	0	0
Berkefeld filter (single candle, No. 13), ...	140	0	0	0	0
London Pure Water Co.'s cistern filter, ...	N.R.	+	+ +	+ + +	N.R.
Maignen's field service *Filtre Rapide*, A.M.D,...	N.R.	0	0 (?)	+ +	N.R.
Silicated carbon syphon filter, A.M.D., ...	N.R.	0	+ +	+ + +	N.R.
Stoneware filter with sponge-plug, A.M.D., ...	N.R.	+	+ +	+ + +	N.R.
Morris's 4-gallon domestic filter, A.M.D., ...	N.R.	0	+	+	N.R.

A.M.D. denotes Army Medical Department.
N.R. denotes "Not recorded".
The times given in the first column are approximate only.
The number of crosses in the table indicates the larger or smaller proportion of the substance in suspension which passed through the filter and appeared in the filtrate.
The substances used in these experiments were the finest gunpowder charcoal (Enfield) particles, 24 μ (micromillimetres) to 0·9 μ; artificial ultramarine particles, 16 μ to 0·6 μ, or even less; and milk minute granules and globules of fat, 0·5 μ to 30 μ in diameter.
* Positive result not obtained, but when treated with suspensions of test organisms, all these filters allowed of their direct passage. † Possibly due to chemical interaction. ‡ Filtering material became clogged.

II. **Iron** in the form known as spongy iron or as magnetic oxide, either
(*a*) Alone, or
(*b*) In conjunction with asbestos cloth.
III. **Asbestos** in various forms, either
(*a*) Alone as a fine film, or
(*b*) As a film in combination with cellulose, or
(*c*) Along with some finely-powdered or granular medium.
IV. **Prepared Porcelain and other Clays.**
V. **Natural Porous Stone,** either
(*a*) Alone, or
(*b*) With other substances, such as powdered carbon, &c.
VI. **Compressed Siliceous and Diatomaceous Earths.**

The result of these careful and scientific experiments is not only to emphasize the conclusions arrived at by the 1886 Berlin inquiry, quoted above, but also to show that, among all the filters enumerated, only two withstood the first test necessary to prove the germ-tightness of a filter, namely the Pasteur (Chamberland) and the Berkefeld. The filtering appliance in each of these is a tube or "candle", through which the water passes, but in the former the candle is made of porcelain, while in the latter it is of compressed Kieselguhr earth.

Various and more searching experiments were made with most of these filters, the full particulars of which were published in *The British Medical Journal* on August 18, November 10, 17, 24, and December 15 and 29, 1894. All the experiments bear out fully the results of the original trials already quoted.

The Pasteur (Chamberland) and the Berkefeld filters underwent a searching investigation during the inquiry carried out by Dr. Plagge for the German War Office (Berlin, 1895). Both these filters are essentially for high-pressure services, though they also filter slowly with low-pressure. Dr. Plagge's numerous experiments with these two forms of filter led him to sum up greatly in favour of the Berkefeld, owing mostly to its greater output, though he allowed that the Pasteur would be an ideal filter, if, with an equal degree of germ-proofness, it gave a tenfold yield of water. In this respect it falls short of the standard of usefulness, and this paucity of yield is shared by all porcelain filters hitherto made. "A filter of six Pasteur candles will yield in 24 hours about 40 gallons, whereas a single ordinary Berkefeld candle yields 40 gallons in $1\frac{1}{2}$ hours—both filtering under a pressure of $2\frac{3}{4}$ atmospheres" (Plagge).

Filters of the porcelain-candle type have recently found many imitators, and some now in the market appear to promise good results. They all need pressure of water to perform their function usefully, and are therefore collectively called

"pressure filters". The most recent investigations on the usefulness of pressure filters have been made by Drs. Sims Woodhead and Cartwright Wood. The results of these investigations were published at length in *The British Medical Journal* of January 22, 1898, and with their previous report on non-pressure filters (already referred to and quoted from) are reprinted in pamphlet form, and obtainable at the offices of the British Medical Association, 429 Strand, London. This pamphlet will be found to give the fullest information as to the methods of testing and the results obtained with the various filters, and should be read by all who wish to know more of the scientific and medical aspect of the question than can be included in a practical work such as the present. In this later investigation, pressure filters alone were tested, and with such results that certain filters can be confidently recommended for general use as perfect safeguards against water-borne disease. It must be remembered that the makers of every variety claimed this perfection for their filters, but only six were found to justify the statement.

Table XXXIX.

TESTS OF PRESSURE FILTERS BY DRS. WOODHEAD AND WOOD.

Filter fed with tap-water containing on the average 40–60 micro-organisms per c.cm.	Average number of organisms in filtrate per c.cm. on each day.						
Name of Filter.	1st.	2nd.	3rd.	4th.	5th.	6th.	7th day.
Silicated Carbon Filter, ...	0?	26	60	200	1000	innu	merable.
Maignen's Filtre Rapide,...	0	40	150	9000			
William Dalton's, ...	20	30	80	100	150	...	300
Jacob Barstow & Sons', ...	5	25	250	300	400		
Piefke Filter, ...	20	30	70	400	500		
Pasteur-Chamberland, ...	0	0	0	+			
Berkefeld, ...	0	0	0	+			
Aëri-Filtre-Mallié, ...	0	0	0	0	0	0	none up to 9th day.
Porcelaine d'Amiante, ...	0	0	0	0	0	0	none up to 30th day.
Pukall Filter, ...	0	0	0	+			
Slack & Brownlow's, ...	0	0	0	+			
Duff's Patent, ...	0	0	+				

The sign + denotes the day on which the organisms appeared in the filtrate, not by direct passage, but by growth through the filtering medium.

The tests to which the filters were subjected were numerous and searching. They included:—

1. *Tests with organisms usually found in all waters*, as to whether they passed directly through the material, or only appeared in the filtrate after such time as they might be expected to take to grow through the filtering medium (a very important distinction).

2. *Tests with chromogenic organisms*, easily demonstrated in the filtrate by the property they possess of forming coloured growths when cultivated on gelatine.
3. *Tests with cholera and typhoid-fever bacilli*, (*a*) in sterilized tap-water; (*b*) in New River water; (*c*) in contaminated water taken from the Thames near Waterloo Bridge, at low tide,—as bad a water as is ever likely to be used for drinking purposes; and (*d*) in undiluted London sewage.
4. *Tests with cholera and typhoid-fever bacilli and filters on which a scum had been allowed to accumulate* from the lengthened filtration of ordinary tap-water and of impure water, which scum would be thought to be a good pabulum for the growth and multiplication of such bacilli.

Some of the filters were not able to stand the earlier of these tests, whilst others triumphantly withstood the whole series. They are consequently divided into two groups:—

1. "*Those filters which allow the direct passage of test-organisms into the filtrate.*"

These were by the following makers:—The Silicated Carbon Filter Company; Maignen's "Filtre Rapide" and "Anti-Calcaire" Co., Ltd.; William Dalton; Jacob Barstow & Sons; Arnold & Schirmer (Piefke Filter); Chabrier Jeune et Cie. (Filtre Universel).

For these filters the most perfect results were claimed; for instance, the vendors of the first-named say that it "yields an absolutely sterilized water under any pressure", also that it "is invaluable in the tropics and in all climates as a safeguard against cholera, typhoid, and other zymotic diseases". A reference to Table XXXIX. will show how far the first part of the statement agrees with actual experiment. Cholera bacilli were easily demonstrated in the filtrate, when the reservoir was fed with an emulsion of these germs.

2. "*Those filters which do not allow test-organisms to pass directly into the filtrate.*"

These were by the following makers:—

1. J. Defries & Sons, Ltd. (Filtre Chamberland Système Pasteur).
2. Berkefeld Filter Company, Ltd.
3. Aëri-Filtre-Mallié, Théories Pasteur, Porcelaine d'Amiante.
4. Royal Porcelain Factory, Potsdam (Pukall Filter).
5. Slack & Brownlow.
6. Witty & Wyatt, Ltd., Agents (Duff's Patent Germ-proof Filter).

Tested with pathogenic or disease-bearing germs, these passed freely through the filters in the first list, but were completely arrested by those in the second list. After even six or eight weeks' exposure to the action of cholera and typhoid-fever bacilli, a sterile filtrate was obtained from Chamberland and Berkefeld filters, although numerous living pathogenic germs were still demonstrable on the outer surface of the candles. Like experiments were performed with the rest of the filters in the second list, with similar results.

Having now six trustworthy filters from which to choose, it only remains to contrast their **practical utility** as regards (1) liability to injury, (2) ease of cleansing, and (3) output of filtered water.

1. *Liability to injury*:—The advantage which porcelain candles possess over the Berkefeld, in being less brittle, is considerable. Duff's patent germ-proof filter, of natural porous stone, is at present so fitted together, that it is, owing to the unequal expansion of the metal and stone parts, very liable to crack when raised to the high temperatures necessary for sterilization.

2. *Ease of cleansing*:—The porcelain filters cannot be so easily or so perfectly cleansed, as the Berkefeld is, by simply boiling. The Berkefeld candle must be put into cold water and boiled up in it, not plunged direct into boiling water. It should be allowed to cool down with the water after boiling for an hour.

3. *Output of filtered water*:—The quantities rendered by the various filters can be seen at a glance from Table XL. The figures are the average results of many experiments with different candles. The rate of filtration of individual candles, by the same maker and sold as identical, was found to vary within somewhat wide limits,—namely, as 1 : 3, or even more,—owing to variations in thickness, presence of air-spaces, &c. The table also shows how the output diminishes, as the fine pores of the filtering medium become blocked up by impurities. The rate of output is restored by brushing the surface of the candle with a hard brush, or by sterilizing by fire or boiling.

The most useful form for household use is one which is affixed to a tap connected with the main, similar to the Berkefeld filter shown in fig. 706. The water enters the outer case, which is of cast-iron enamelled inside and painted and varnished outside, and percolates through the material of which the filter is composed (Kieselguhr or porcelain), until it reaches the hollow inside the candle and is forced up through the outlet-pipe T. By turning the thumb-screws, the filter can be taken bodily out, cleared externally if only clogged, or sterilized by boiling if it has worked its period. Means have been applied to both filters, by which they can be scrubbed by revolving brushes without removal from the case;

Table XL.

TABLE SHOWING THE AVERAGE[1] AMOUNT OF WATER GIVEN BY VARIOUS FILTERS

(compiled from observations made by Drs. Woodhead and Wood).

Name of Filter.	Average time required to filter one pint.		Average time taken to filter one litre.			Calculated quantity filtered in 24 hours.		
	Pressure.	Time.	1st day.	2nd day.	3rd day.	1st day.	2nd day.	3rd day
Filtre Chamberland,[2]	24 lbs.	3 mins. $53\frac{1}{2}$ secs.	6 mins.	9 mins. 11 secs.	16 mins. 59 secs.	$46\frac{2}{3}$ gals.	$25\frac{2}{3}$ gals.	$16\frac{1}{2}$ gals.
Berkefeld No. 1,[3]	24 lbs.	28 secs.	50 secs.	1 min. 34 secs.	2 mins. 55 secs.	293 gals.	172 gals.	95 gals.
Berkefeld No. 14,	24 lbs.	48 secs.	1 min. 41 secs.	3 mins. 53 secs.	8 mins. 21 secs.	$136\frac{1}{3}$ gals.	61 gals.	$31\frac{1}{3}$ gals.
Porcelaine d'Amiante,	16 lbs.	1 hour 8 mins.	Too slow for ordinary utility.					
Pukall,—small,	16 lbs.	8 mins.	Output declines very rapidly.					
,, medium,	16 lbs.	5 mins. 6 secs.						
,, large,	16 lbs.	2 mins. 16 secs.						
Slack & Brownlow's,	24 lbs.	1 min. 42 secs.	After 24 hours $\frac{1}{3}$, and after 48 hours $\frac{1}{6}$ of original output.					
Duff's patent filter,	24 lbs.	$15\frac{1}{2}$ secs.	Diminishes rapidly, but experiments insufficient for exact estimation.					

[1] The filtering capacity of candles ostensibly the same varies very considerably; thus, the time taken to filter one pint of water (under a pressure of less than 24 lbs.) ranged between 118 and 426 seconds with Pasteur (Chamberland) candles, 25 and 31 with Berkefeld No. 1, 38 and 51 with Berkefeld No. 14, and between 85 and 136 with Slack and Brownlow's.

[2] See fig. 708, page 423.

[3] See fig. 706, page 421.

these for many reasons cannot be recommended. Another plan of cleansing is more satisfactory. Taking advantage of the fact that filtration is chiefly effected on the surface of the filter, the plan has been devised of making a temporary and easily removable surface. A certain amount (varying with the filtering surface) of Kieselguhr, a finely-powdered diatomaceous earth, is mixed with the water in the receiver, and the filter is then placed in position and the supply-tap turned on. As the pressure comes to bear, the water filters through, and the fine particles of Kieselguhr in suspension are deposited all over the surface of the candle and form a superficial filtering film, which stops the greater part (if not all) of the suspended impurities. This false surface is exceedingly easy to remove by rinsing or lightly brushing. It can be brought off, almost as a mould of the candle, by pumping a little air into its bore, whilst the whole is held under water. A pump for bicycle pneumatic tyres, screwed on to the delivery-pipe, serves the purpose well. By this means the bulk of the impurities are easily removed from the actual filter, and at the same time the diminished output of filtered water, which naturally takes place from clogging of the pores, is to a great extent prevented. The following table, containing the results of tests with a No. 1 candle, illustrates this:—

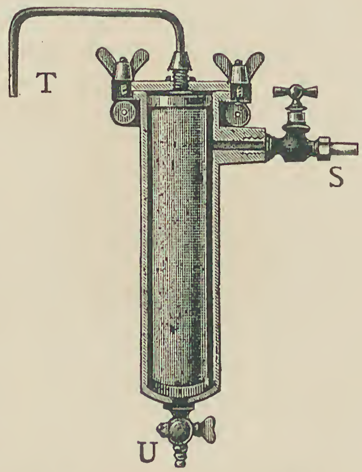

Fig. 706.—Berkefeld Single-tube Filter. S, water-supply; T, filtered-water outlet; U, flushing tap.

TABLE XLI.

PASSAGE OF WATER THROUGH FILTERS WITH AND WITHOUT KIESELGUHR.

Filter with and without Kieselguhr.		1st day.	2nd day.	3rd day.
Time taken to filter one litre in seconds.	Without Kieselguhr,	52	68	147
	With Kieselguhr,	56	65	88
Calculated quantity filtered in 24 hours in gallons.	Without Kieselguhr,	316	178	90
	With Kieselguhr,	314	248	192

The Berkefeld filter, illustrated in fig. 706, is said to yield upwards of 100 gallons of pure sterile water per day, if the supply has a pressure of 35·40 lbs. This, of course, is sufficient for the pure-water requirements of ordinary houses. Where more water is required, filters containing more candles must be used, such

as shown in fig. 707, which has seven candles; filters containing almost any number of candles are now made. Fig. 708 is an elevation of a Pasteur (Chamberland) filter attached to an ordinary tap, while fig. 709 is the same filter connected with a stoneware reservoir for the filtered water. Such reservoirs, however, should not be used except in cases where the intermittent nature of the supply renders them absolutely necessary.

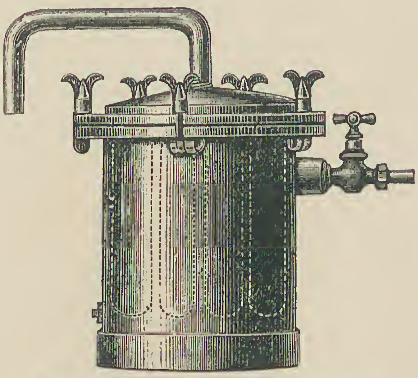

Fig. 707.—Berkefeld Filter, with Seven Tubes.

Numerous other adaptations of both the Pasteur and Berkefeld filters can be obtained, including cistern-filters, portable filters, &c.

In concluding their report, **Drs. Woodhead and Wood say**:—"The efficiency of a filtering medium . . . depends on the size (and regularity) of the channels by which it is traversed; . . . all porcelains do not arrest the direct passage of organisms. The most perfect filter, from a scientific point of view, which we have seen, is undoubtedly the Porcelaine d'Amiante, but unfortunately the rate of filtration is so slow that the use of this filter for domestic purposes appears to be out of the question. We should like again to insist upon the necessity of all the water required for domestic purposes being filtered where it is considered necessary that the water to be used for drinking purposes should be subjected to this process. Inasmuch as the more pervious porcelains can be relied on to arrest the passage of infective disease germs, they are naturally much more suitable for all practical purposes. The compressed diatomaceous earths as used by the Berkefeld Filter Company furnish a much less perfect filter from the strictly bacteriological point of view than the porcelain; they are nevertheless capable of arresting the passage of disease-organisms, and have the great advantage of affording a larger output.

"We regard this rapidity of filtration as an all-important point in discussing the applicability of any filter for domestic purposes.

"The same amount of output as from the Berkefeld filter may no doubt be obtained by combining a number of porcelain candles of slower filtering capacity, but we have already insisted upon the risk of a leak, and the whole object of filtration being frustrated from the multiplicity of fittings thus involved, and we are accordingly unable to recommend any such arrangement.

"We are of opinion that experiments carried out with the more porous materials, such as diatomaceous earths or natural stone, rather than with denser media such as porcelain, are more likely to lead to the production of the filter of the future"

Where water-pressure is not available and a non-pressure filter must be used, **its position should be carefully selected.** It ought to stand in the light and in as pure air as possible, and not in a pantry or kitchen, or near a sink, opening of a drain, drain-ventilator, w.c., dust-bin, &c. Water, like milk, has the power of absorbing gases from the air, and when these are foul the water will taste of them. This power of absorption is especially great when water is cooling, a state

Fig. 708.—Single-tube Pasteur (Chamberland) Filter.

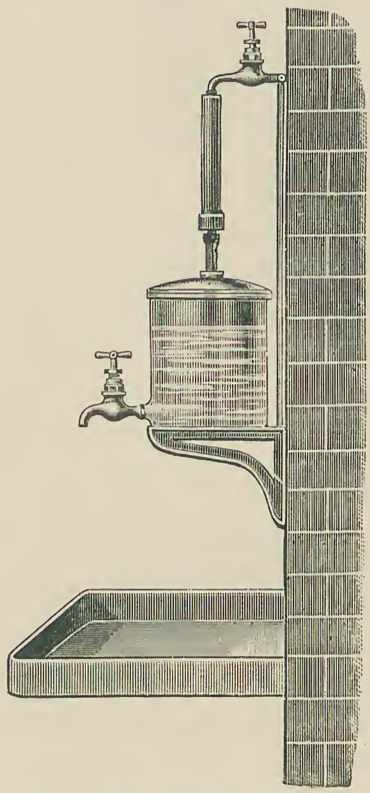

Fig. 709.—Pasteur (Chamberland) Filter, with Stoneware Reservoir.

in which it is found in the filter when boiled previous to filtration. A greater safeguard would be to boil the water after filtration, and then cool and aërate it to render it palatable by letting it fall from the height of a few feet, in fine streams, such as are formed by its passage through a fine hair sieve, or by letting it run through a loose mass of broken bricks. Boiling drives off the carbon dioxide gas naturally present in water, and its loss renders the water dull, and mawkish to the taste. The aëration is merely to replace this lost constituent.

Some of the very fine-meshed filters, notably the porcelain ones, have the same effect upon the taste of water as boiling has, and for the same reason, only the bubbles of gas are not driven off, but stopped mechanically; the same remedy can be used. This applies also to ordinary non-pressure filters.

Comparing the relative merits of **boiling and filtration** as means of sterilizing water, we find that each has its advantages. If garden-mould be stirred into water, and the mixture boiled, the micro-organisms will be reduced in number from 30,000 to 160 per cubic centimetre after five minutes' boiling, but even after boiling for two hours there will still be some resisting spores left alive, which can multiply rapidly under suitable conditions. In this respect a good germ-proof filter holds a distinct advantage. It is a fact, however, that the bacilli of cholera and typhoid are readily killed by a temperature of 180° F., that is to say, 32° F. below the ordinary boiling-point of water. The best results can therefore be obtained by combining boiling and filtration.

When the only water obtainable is full of **suspended matter**, which would quickly clog any filter, a method introduced by Mr. G. Embery in the Gloucester district can be recommended. By its use the water is not only cleared, but much improved in quality. It is only necessary to know the number of degrees of temporary and permanent hardness[1] of the water in question. A tank holding about 50 gallons, with a funnel-shaped bottom and two taps (see fig. 710), is filled with the water, and to it is added a quantity of slaked lime in grains per gallon equal to three-quarters of the number of degrees of *temporary* hardness; *e.g.* for 12 degrees of temporary hardness, add 9 grains of slaked lime to every gallon of water. Also twice as many grains per gallon of washing-soda as there are degrees of *permanent* hardness must be added; *e.g.* for 6 degrees of permanent hardness, add 12 grains of washing-soda to every gallon of water. The water thus treated is allowed to stand for about twelve hours, and the softened clear water is then drawn off at the tap A; the tank may then be refilled with water, and a fresh charge of lime and soda added. After three or four charges have been thus treated, the tap B is opened, and the mud, which has settled, is allowed to escape, and the tank thoroughly cleaned. This procedure does not, of course,

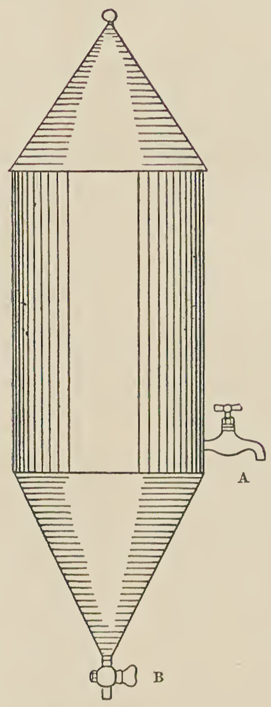

Fig. 710.—Simple Apparatus for softening water.

[1] For the explanation of *temporary* and *permanent* hardness, see § III., page 241, Vol I.

obviate the necessity of boiling and filtering the water before using it for drinking.

Most filters lessen **the hardness of water** to some extent. Spongy iron, silicated carbon, and magnetic carbide are all good mechanical filtering media, whilst in addition a considerable oxidation of organic matter takes place owing to their capability of condensing oxygen.

Against **lead-contamination,** no filtering medium is so efficacious as animal charcoal, though even this can only remove small traces. Vegetable charcoal is less useful in this respect.

The following **summary of the advice** here given as to the use and choice of filters will be useful:—

Where a constant public supply, drawn direct from the mains, is used, or where deep-well water or spring-water is available, no filter is needed, nor should any be used, except in times of epidemics.

When the supply is from any doubtful source,—river, stored rain-water, shallow-well or surface water,—a competent filter is desirable. Wherever it is possible, the water should be raised to such a height as will allow a pressure filter to be used.

The choice of filter will largely depend upon the character of the water to be dealt with. On this head it is always advisable to consult the public analyst of the district, whose knowledge of the local water-supplies is usually accurate and exhaustive. For a small fee he will make a special analysis of the water in question, giving much useful information as to its ingredients, hardness, &c.

The most suitable filter having been procured, it must be given fair play. Let it be placed in a light, clean, airy situation, and make one person responsible for the duty of attending to it, keeping it supplied with freshly-boiled water, and cleaning it thoroughly at specified intervals. The filtering material must be occasionally renewed.

In epidemics of infectious disease it is wise to take the additional precaution of reboiling the water after filtration, and afterwards to aërate it and cool it in the open air, except where one of the six trustworthy filters is used with discretion.

Section XVIII.

CLIMATE AND SITUATION

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SECTION XVIII.—CLIMATE AND SITUATION.

CHAPTER I.

METEOROLOGY.

"**Climate** is the general resultant of temperature, atmospheric pressure, humidity, rainfall, and other less-known factors, modified by soil, aspect, and various local conditions."

Temperature is primarily dependent upon latitude, but is locally and periodically modified by the direction and character of the ocean-currents and prevailing winds, whether warm or cold; thus, Labrador and Newfoundland are in the same latitudes as the British Isles and France, but while the western shores of the latter countries are washed by the warm Gulf Stream from the West Indies, the former are chilled by the icy currents flowing southwards from the eastern coasts of Greenland and Baffin's Land, and by the westerly gales from the Pacific which, though warm and moist when they beat on the wooded hills of British Columbia, have been changed in their passage across the bleak wilds of Rupert's Land. These general characters of eastern and western shores may also be observed in our own islands, in the contrast between the dry, bracing climate of the east coast from Norfolk to Aberdeen, and the mild, humid climate and heavy rainfall of Ireland, Wales, Devon, and Cornwall. And the unimportant part played by latitude alone is shown in the fact that so far north as the Shetlands snow rarely lies many days together, though the extreme humidity of the air and the absence of dry heat preclude the maturation of cereals, oats excepted. Yet there are, even within narrow limits, modifying influences, as in the valley of the Shin in Sutherland, where crops ripen in the drier air which fail to do so in Argyle, 2° of latitude further south.

Mean temperatures, unless given for every month in the year and with the maxima and minima or range of the monthly oscillations, afford little useful information as to the true character of a climate. No part of Great Britain is remote enough from the sea to produce what is called a continental climate, that

is, one in which hot, dry summers alternate with winters of severe cold and frost, continued until the air becomes clear and dry. Our climate is essentially insular, and in choosing a residence regard should be had to the prevailing winds, rainfall, humidity, the amount of sunshine, and the local features of elevation, aspect, and soil. In mild and humid districts, as Devon and Argyle, small tracts of moderate rainfall may be found, and in colder and drier regions, as Yorkshire and the N.E. of Scotland, there are spots or areas sheltered by hills from the biting east and north-east winds.

Air is capable of holding in an invisible and impalpable form a quantity of **water-vapour** varying with the temperature but increasing more rapidly as this rises. Even when the temperature is far below freezing the air is not absolutely dry, holding about 1 grain of water in the cubic foot. The air is said to be saturated when it contains as much water as, at that particular temperature, it can hold without depositing any as dew; and *vice versâ*, given a certain amount of vapour, the temperature at which it would begin to fall is called the dew-point. The proportions for saturation are 2 grains at 30° F., 3 grains at 40°, 4 grains at 50°, 6 grains at 60°, 8 grains at 70°, 11 grains at 80°, and 15 grains at 90°. The percentage of saturation represents the degree of **humidity**; thus, 4 grains in the cubic foot will be saturation at a temperature of 50° F., 66 per cent of humidity at 60° F., and only 50 per cent at 70° F. In the three instances just cited the air will be felt damp, agreeable, and painfully dry respectively, although the actual amount of moisture remains the same.

As the temperature rises, more vapour is absorbed by the air from the surface of land and water, to fall as **dew** or appear as **mist** should the temperature sink below the point at which the additional vapour can be held (as may be seen on every clear summer evening and night), and to be taken up again invisibly with the returning warmth of day; indeed, there is absolutely more moisture in the air on a hot "dry" day in August than in a cold "damp" day in November; and more in a warmed and occupied room than there is in the open air, especially in winter, the vapour in this case being derived mainly from the breath of the occupants and the combustion of gas.

Table XLII. gives weight (in grains) of vapour in a cubic foot of *saturated* air at temperatures from 14° to 88° F., and the diagram, fig. 711, exhibits the same information graphically. From these it may be seen that at 80° F. the air is saturated by 11 grains, at 60° F. by 6 grains, and at 40° F. by 3 grains; and it is clear that if the humidity be 75 per cent at 60° F., dew will fall when the temperature sinks to 53° F., but if the humidity at 60° be only 50 per cent dew cannot fall until a temperature of 41° is reached. One can thus see how the

young leaves and flowers of fruit-trees are more liable to suffer from light frost in clear nights after warm sunny days, than in the cold, dull weather often accompanying dry N.E. winds; for with a day temperature of 60° and 75 per cent of humidity the lightest frost will cause a heavy deposit of hoar-frost, while

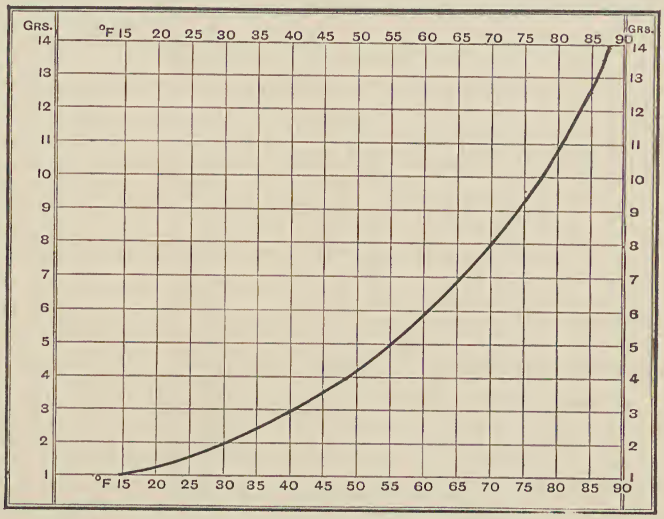


Fig. 711.—Weight (in grains) of water-vapour in a cubic foot of *saturated* air from 15° to 90° F.

with a temperature of 40° and humidity of 50 per cent none will fall unless the night temperature sink to 24°.

TABLE XLII.

Weight (in grains) of Water-vapour in a cubic foot of *Saturated* Air[1] from 14° to 88° F.

Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.	Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.	Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.	Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.	Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.
14	1·0	30	2·0	46	3·6	62	6·2	78	10·3
16	1·1	32	2·1	48	3·8	64	6·6	80	11·0
18	1·2	34	2·3	50	4·1	66	7·0	82	11·7
20	1·3	36	2·5	52	4·4	68	7·5	84	12·4
22	1·4	38	2·7	54	4·7	70	8·0	86	13·2
24	1·5	40	2·9	56	5·0	72	8·5	88	14·0
26	1·7	42	3·1	58	5·4	74	9·1		
28	1·8	44	3·3	60	5·8	76	9·7		

[1] When the air is thus saturated, the readings of the wet and dry bulb thermometers are the same; humidity less than 100 per cent is indicated by the lower reading of the wet bulb.

Evaporation in nature depends not so much on the temperature as on the relative humidity of the air, and its consequent capacity for taking up more moisture; it is therefore greatly aided by wind and movement, which carry off the air as it tends to become saturated and replace it by drier. Evaporation tends to lower the temperature of the air and of the surface-soil, since all bodies in passing from the solid to the liquid, and still more from the liquid to the gaseous state, abstract heat from their surroundings, which they give off again during the reverse transition. Thus, a heavy fall of snow is followed by a perceptible rise of temperature, and the "raw" cold that accompanies a thaw is well known. Thus too is produced the refreshing coolness that follows the use of a water-cart or hose on a hot sunny day, or of the wetted matting curtains in an Indian bungalow.

Rain is the result of the sudden condensation of vapour (or, more strictly speaking, finely-divided particles of water) contained in masses of warmer air in the form of fog or cloud, when these come in contact with colder air or impinge on the cold summits of mountains. It is thus heavier and more frequent on the western coasts, where the vapour-laden winds from the ocean first meet the mountains and hills of that part of Great Britain. On the eastern shores and counties the rainfall is less, since the west winds have already deposited much of their vapour as rain, and those coming from the north and east are for the most part drier.

The average annual rainfall[1] in the British Isles is about 37 inches, the average in England and Wales being 33·76, in Ireland 38·54, and in Scotland 46·56. But in each division of the kingdom there are great variations; thus, in the eastern counties of England the annual rainfall is only 25 inches, while in the hilly or mountainous and moorland districts of Devon, Cornwall, Wales, the Pennine Range, and Cumberland it varies from 40 to 80, and in particular localities it is considerably more than 100 inches. The extreme mean annual rainfalls in England are 15 inches at Thetford in Suffolk, and 145 at Seathwaite in Cumberland. In Scotland and Ireland similar variations occur, the midland and eastern counties being, as a rule, the driest, and the western counties having a rainfall approximating to the English maximum.

The heaviest rainfalls in Great Britain, *i.e.* 80 inches and upwards, are met with in the Isle of Skye and the opposite mainland as far as Loch Linnhe; in the Lake District of Cumberland and Westmorland; on the Snowdon range in North Wales; and over a small area among the South Wales Mountains in Carmarthen. It must not be forgotten that there are great differences in the rain-

[1] See also pp. 193–195, Section III., Vol. I.

fall of different years, especially in the south-west (as at Plymouth, where the extremes hitherto observed have been 45 and 100 inches, and at Exeter 30 and 90), and that, owing to local conditions,—chiefly the disposition of hills or headlands,—there are in the districts of heaviest rainfalls spots in which it is less than the average of those of the lowest; *e.g.* at Sidmouth in rainy Devonshire it is but 32 inches, and at Cockermouth in Cumberland it is only 22, though this town is but a few miles distant from Seathwaite, where the maximum annual rainfall in the British Isles is met with.

There is no relation between the rainfall and the humidity of the air, the latter depending chiefly on the nature of the soil; the heaviest rainfall is frequently found in mountainous places where a hard non-absorbent rock gives but little opportunity for evaporation, and where, therefore, the amount of water-vapour in the air may be, in ordinary circumstances, relatively small. Instances in proof of this may be seen in Table XLIII., which gives a summary of the rainfall, humidity, and temperature at certain well-known health-resorts, together with the nature

TABLE XLIII.—CLIMATE OF HEALTH-RESORTS.

Place.	Subsoil.	Mean Winter Temperature in deg. F.	Mean Summer Temperature in deg. F.	Mean Daily Range in deg. F.	Mean Annual Rainfall in inches.	Rainy Days.	Humidity per cent.
Regent's Park,	London Clay, ...	41·6	56·9	13·8	25·16	164	80
Margate, ...	Chalk, ...	41·8	56·4	10·9	22·98	165	81
Lowestoft, ...	Gravel, ...	40·8	54·8	11·4	24·09	173	83
Cromer, ...	Cragland Blue Clay, ...	40·6	55·4	12·0	27·73	154	85
Scarborough, ...	Loam on Clay, ...	40·8	54·1	10·0	26·68	195	83
Hastings, ...	Sand on Sandstone, ...	42·2	57·0	11·8	29·26	137	82
Eastbourne, ...	West-end Chalk, East Loam,	42·2	56·2	...	29·53	165	...
Brighton, ...	West-end Clay, East Chalk,	42·5	57·1	11·2	30·43	163	78
Southsea, ...	Bagshot Sand and Clay, ...	42·7	55·2	13·8	26·39	173	82
Ventnor, ...	Lower Greensand, ...	44·2	57·7	10·5	28·33	167	80
Weymouth, ...	Sand, Shingle, Clay, ...	43·5	56·8	10·3	27·61	162	81
Teignmouth, ...	Marl, in parts Sand, ...	43·8	57·0	12·4	32·28	169	82
Torquay, ...	Limestone, ...	43·5	55·9	10·8	31·72	177	80
Falmouth, ...	Slate on Quartz, ...	44·9	57·0	9·5	43·49	204	81
Ilfracombe, ...	Shales on Sandstone, ...	44·9	57·0	8·4	31·53	191	85
Llandudno, ...	Limestone, ...	42·7	55·2	10·1	27·52	175	79
Guernsey, ...	Granite, ...	45·5	57·6	9·1	33·28	192	85
Harrogate, ...	......	39·5	53·4	12·7	...	...	82
Malvern, ...	......	41·2	56·3	12·8	...	...	80
Tunbridge Wells,	......	40·9	56·0	14·4	...	...	81

The above averages are for a period of seven years, except for Brighton, fourteen years, and for Harrogate, Malvern, and Tunbridge Wells, eight years. All, except for Brighton, are from the records of the Meteorological Society. It must not be forgotten that the climatic conditions of different places, in the same county or district, vary largely; elevation, shelter, aspect, soil, and the proximity of water and trees, must all be taken into consideration.

of the subsoil in most cases; thus Falmouth, built on hard impervious rock, has nearly 60 per cent *more* rainfall than Cromer, but 5 per cent *less* humidity.

The dew-point is the temperature at which air in the course of cooling can no longer retain its water as an invisible vapour, but lets it fall in minute drops which, according to circumstances, take the form of **dew, hoar-frost, fog,** or **mist.** The warmer the air the more moisture does it take up from the soil, rivers, sea, &c. While the sun is shining, the earth receives and absorbs more heat than it loses by radiation into space; but at night, unless radiation be checked by overhanging trees or clouds, and there be not enough wind to keep the lower air in constant movement, the earth rapidly cools, and in so doing brings down the temperature of the air in contact with it. When the temperature of the air falls below its dew-point, some of its watery vapour is deposited, either as **dew** or as **hoar-frost**—according as the dew-point is above or below 32° F.,—and most abundantly on those objects, as grass and twigs, which are the best radiators. Hoar-frost is not frozen dew, but dew deposited in the form of ice from air whose dew-point is below freezing.

The formation of fog, unlike that of dew, is favoured by a moderate movement of the air, and indirectly by irregularity of the surface of the country. It results from the rapid cooling of large masses of air to below their dew-point, (1) by the mingling of volumes of warm humid air and cold dry air (provided the temperature of the mixture be below its dew-point), (2) by the sudden chilling of vapour-laden air when it impinges on cold hilltops or cliffs, (3) by the air passing over land cooled by evaporation, as wet clay soils, or (4) over the surface of lakes (provided the water in these be colder than the air). The fogs which form over running streams in frosty weather are, however, due to the condensation of the vapour rising from the warmer water; and in valleys and over damp meadows fog is often caused by the colder and therefore heavier air from the higher lands around flowing down and condensing the vapour in the warmer air in the valley, which, if there be little or no wind, may gradually assume the appearance of a lake of white mist.

Though fog and mist, which differ only in the size of the coalescing drops of water, may, like dew, saturate the clothing of persons exposed to them, they are by no means necessarily indicative of dampness of site. No such suspicion attaches to those that cap the summits of high hills, or veil the cliffs and headlands of the southern and western coasts, or to the fogs to which the heights along the course of rivers are exposed; but the case is totally different when they mark the sites of ponds and water-courses that have disappeared through drainage, or haunt low-lying clay-lands and tracts where the ground-water is near the surface.

In and near towns, where the air is charged with smoke, the particles of carbon attract and condense the moisture of the air, and form fogs which are marked by a yellow or brown colour and a pungent acid and tarry smell.

CHAPTER II.

THE SITE.

It is only in the country that one has a perfectly free choice as to the site of a house, including the several conditions of **soil, elevation,** and **aspect.**

Soil.—The influence of soil is more felt in the country than in towns, where paving and drainage tend to obliterate the differences due to greater or less permeability. Generally speaking, granite, slate, sandstone, and limestone rocks provide the very best sites; sands, gravels, and chalk are next in order of merit, provided they are deep and free from an admixture of clay; while marls, brick-earth, and clays are the worst, since they absorb but little of the rain, but hold it in every depression until it evaporates.

Surface accumulation, however, can always be prevented by paving and surface-drainage; **ground-water** is usually a more important point for consideration, and is, at the same time, far more difficult to deal with. No site can be considered healthy where the ground-water is found at less than 12 feet from the surface, or 15 feet if its level be subject to considerable fluctuations. If nearer than 15 feet its level should be, as far as possible, lowered and fixed by subsoil drainage; and the area on which the house stands should be covered with concrete or asphalt, to prevent the ascent into the building not only of moisture but of the ground-air, whether through the rise of the ground-water, or the warmth of the house. Pervious soils, as chalk and gravel, if forming beds of 10 or 15 feet in thickness over an impervious bed such as clay, are among the most dangerous and deceptive of sites, since the ground-water will probably be found within a few feet of the basement, and may at times rise into it; and should there chance to be a depression in the clay at that spot, the house will practically stand over or in a concealed pond. In the case of a river-side house—if it cannot be at any considerable height above the river,—a clay soil, the stiffer the better, is far preferable to one of gravel, as the latter will be permeated by water, which will rise and fall with the river itself. The more permeable a soil the more liable it is, with its ground-water, to become polluted by soakage from cess-pits, dung-

yards, and foul ponds,—a danger which in the case of chalk is increased by the frequent occurrence of fissures of extreme length.

A good fall to assist surface-drainage as well as that of the house and subsoil is always desirable, but in building on a **steep hillside** several precautions are necessary. On no account ought a house to be built against a cliff, whether a natural one or formed by excavation: and if the hill rise abruptly within a short distance, a deep trench should be dug along it to receive and divert the surface-water and storm-water from the site of the buildings; such a trench may, if made large enough and planted, add to the beauty of the grounds. Another site to be avoided is the line of contact on a declivity between a superposed pervious and a subjacent impervious bed, if the plane be not in an opposite direction to that of the surface, since the ground-water in the upper bed will emerge along this line in the form of springs, at any rate after heavy rains.

So, too, in building on **clays**, seams of gravel, which act as drains for surface-waters, and give rise to "land-springs", should be looked for and drained. A further objection to clays is their tendency to shrink during long periods of drought, thereby leading to sinking of foundations and cracking of walls.

Unless well protected by plantations of pines or other evergreen trees, houses on **plains** are exposed to cold winds; whereas in hilly, or even in undulating districts, it is not difficult to select sites that shall be sheltered from cold or stormy winds and yet enjoy the maximum of sunshine at all times of the year. But a further advantage sometimes obtainable in hilly countries is that, by certain arrangements of ranges of hills of even moderate altitude, rain and thunder-clouds are diverted, so that particular localities or valleys may enjoy an exemption from the heavy rainfalls general in the district, and a drier and warmer climate than their geographical position would lead one to expect. Cockermouth, Sidmouth, and other places already referred to, are examples in proof.

Fig. 712 represents the banks of a river, rising on one side as lofty cliffs, with villas or cottages perched picturesquely on every ledge; AA is a bed of gravel or drift resting on the rock BB, which is capped on the right by a stratum of sandy soil CC. The gravel is traversed by a river D, and the ground-water stands at the same level, EE, as the stream. The house F is sufficiently raised above the ground-water to be dry and healthy, but G on the other hand is not; indeed, should there be any considerable rise of the water, it must mount into the cellars. The houses H and I are each on the rock, but while H is well away from the cliff, and the storm-waters descending the slope will be carried off by the trench L, the other house I is built against the cliff and will inevitably be damp and unhealthy, exposed not only to storm-waters but to the drainage from CC, which in wet

weather may issue at C′ like a spring. The position of the house K is healthy though bleak.

The most potent factor in the healthiness of a locality is **the soil**, and it was a no less wise than witty saying of the great German hygienist, Pettenkofer, that "we do not go from home for change of air, but for change of soil". The ceaseless movements of the air preclude any appreciable differences in its actual composition, but the most diverse climates may occur within a few

Fig. 712.—Some House-sites.

miles, as in the familiar instances of East and West Brighton, or Bromley and Penge in South London. The influence of the soil on temperature, radiation, humidity, and evaporation is marked and manifold. The heavest fall of rain sinks deep into the chalk, leaving the ground as dry as before, while on clay the water lies slowly evaporating for days or weeks, rendering the atmosphere damp and cold. Granite, trap, mountain-limestone, slate, and marble, may for practical purposes be considered impervious. Sandstones and chalk are decidedly porous, and capable of absorbing a considerable amount of water, which displaces the air that filled the pores when the rock was dry. Water, however, not only sinks into pervious rocks and soils, but rises upwards in them by capillary attraction, and to a greater height the finer the structure and smaller the pores; on the other hand, it sinks more easily and rapidly into the coarser rocks and looser and coarser soils. The constituent particles of clay are of extreme fineness, and in the dry state would be described as dust; hence the capacity of clay for passing air or water through it is less than half that of loam, and perhaps one-hundredth that of sand and gravel.

Much of the rain absorbed by the surface-soil is, if the humidity of the atmosphere be considerably below saturation, returned to the air by evaporation, as is that which rises to the surface by capillary attraction. But heavy and repeated rainfalls force the water already in the soil progressively downwards, until it meets with a more or less impervious stratum of rock or clay, where it tends to accumulate, and to form a sheet of water filling the interstices between the

particles of the soil. This "**ground-water**", as it is called, moves in the direction of the incline of the solid bed on which it rests, and with a velocity proportioned to the gradient and to the looseness of the soil in which it is held. If owing to denudation it come to the surface, a spring is the result. More often it makes its way to a river, the volume of which it helps to swell; but in sandy soils the reverse sometimes occurs, and the river by percolation through its bed serves to feed the ground-water. Such, indeed, is the sole source of the water obtained from wells in the valley of the Nile, where the rainfall is insignificant, and, owing to the extreme dryness of the air, evaporates almost immediately. Ground-water is everywhere liable to pollution by percolation from foul ponds or cess-pools, since the water from these enters the soil at a depth to which the bacteria, whose function it is to convert organic into inorganic matter, do not penetrate.

When the upper layers of the soil are not saturated with water the interstices are occupied by air, largely composed of carbon dioxide, and containing also other gases, the products of the decomposition of organic matter. With the rise and fall of the ground-water, and with variations in barometric pressure, the **ground-air** is forced out or atmospheric air drawn in. In order to prevent the rise of the ground-air and moisture into the dwelling—a danger to be especially feared in winter when the air of the house is warmer than the ground-air,—it is necessary to cover the site of the house with an impervious layer of concrete or asphalt.

Pettenkofer, the great authority on all that concerns the movements of water and air in the soil, is of opinion that the carbon dioxide in both is due to the action of bacteria, analogous to those of nitrification, on the organic matter in the soil, and that the fatal results of incautiously entering vaults in cemeteries have been caused, not by mephitic exhalations, but, precisely as in like descents into wells, by the accumulation of carbon dioxide from the soil. But whatever other gases the ground-air of the country—that is to say, under natural conditions—may contain, there is no doubt as to the impurity of that in the town. Coal-gas is always present from the yielding of the joints in the gas-mains under the vibration of the traffic in the streets. Cases of poisoning, with symptoms not unlike those of typhoid, are often observed on the Continent and in America, where the winter is more severe than here, and especially in underground rooms, though there may be no gas laid on to the house. Pettenkofer has experimentally shown that it is not, as is commonly supposed, that the frozen surface-soil will not permit the gas to escape into the atmosphere, but that the ground-air is drawn, even for some hundreds of feet, in the direction of buildings the interiors of which are at temperatures much above that of the earth and outer air, and

this, too, irrespective of the actual temperature or time of year. Coal-gas may produce serious consequences without being suspected, for the poisonous constituents are inodorous, the characteristic smell of gas being due to tarry and oily matters which the soil, until it becomes saturated with them, may effectually arrest.

The **temperature** of the surface of the earth on a cloudy day follows the changes in that of the atmosphere, but when exposed to the direct rays of the sun, the soil absorbs heat and acquires a higher temperature. Dark, coarse, dry soils absorb most, and may attain a temperature of 50° C. (122° F.) or more; light-coloured, fine, and moist soils absorb least heat, and its emission by radiation is proportioned to the absorption, though, in consequence of evaporation, a soil cools more rapidly when damp than when dry. Dry soils of any kind are thus rightly deemed warmer than those which are constantly damp.

"**Made earth**" is the euphemistic expression current among builders for the rubbish, ashes, dust, and "slop" with which they find it profitable to fill natural or other hollows of a building-site. Being, like the contents of dust-bins and the road-sweepings, of which it chiefly consists, largely composed of animal and vegetable refuse, it is liable to putrefy and ferment for years, with the gravest consequences to the health of the occupants of the houses as well as to the stability of the buildings. It is most to be feared on sites ostentatiously advertised as fine deep gravel or sand, since it pays the builder well to excavate and sell these materials, and to substitute rubbish which costs him nothing, and for taking which, indeed, in some cases, payment is made to him.

The influence of soil on health is undoubtedly modified to a great extent by drainage and building. No one now associates agues with the fashionable London quarter of Belgravia, yet at one time the marshes of Ebury were scarcely habitable.

Much has been written of late on the distribution of diseases in the British Isles, and many unintelligible conclusions as to the connection between the geological formation and the prevalence of certain diseases have been drawn from mere statistics, the *veræ causæ* being lost sight of meanwhile. That **malarious disease**—the so-called remittent, intermittent, or marsh fevers, and agues—are rooted to the soil in certain localities, no one doubts; nor that, apart from the bacterial theories of its causation, the "malaria requires for its development a soil containing organic matter in excess of the needs of the vegetation, together with a certain degree of temperature and of humidity, all three factors being essential". Unknown in arctic regions, it appears in such as Finland only in unusually warm summers; further south it prevails constantly in summer or autumn; and in hot climates it is always present except during prolonged drought. Its

absence from places at considerable elevations is only accidental, for where, as in Mexico, Armenia, and elsewhere, the above-mentioned conditions are found, it may be met with at many thousand feet above the level of the sea. It is most prevalent while the ground-water is subsiding, but complete submergence or desiccation of the soil arrests it. Drainage of the subsoil, and cultivation, serve to reduce or even to abolish it, provided the crops are not, like rice and sugar-cane, such as require irrigation. In climates, however, like those of West and Equatorial Africa, and in the deltas of great tropical rivers, the task of eradicating the disease is obviously impossible. Ague still holds its ground in the Fen Country of Lincoln and Cambridge, and in Romney Marsh in Kent, though it is less general and of a far less severe type than formerly. It also lingers here and there in other parts of the country. The remittent and the intermittent (quotidian, tertian, and quartan) fevers differ only in degree and pass one into another, the intensity and the fatality being greater in warmer than in colder climates.

Goitre is a disease which appears to be caused or favoured by the use of waters from the dolomitic or magnesian limestone rocks — at any rate, under certain ill-understood conditions. It occurs occasionally in all places, however, but is not so prevalent now in Derbyshire as formerly. In some Alpine and Himalayan valleys it is endemic, as it used to be in the district of the Peak in Derbyshire; and when the present water-supply from the magnesian limestone was provided at Sunderland, fears were loudly expressed as to the consequences, but no ill effects have been observed. Dr. de St. Lager, from a study of the French conscripts, came to the conclusion that the combination of iron with the salts of magnesium and lime was necessary to induce goitre, but other observers attach more importance to the habits of the people as bearing on the circulation and action of the heart. The whole question is, in fact, involved in obscurity.

Rheumatic affections are prevalent in cold, damp soils, but acute rheumatism, or **rheumatic fever** so called, is more frequent in dry, windy, and comparatively warm situations and seasons, being, as is now generally accepted, a totally different disease.

Phthisis or consumption, both in the tubercular and the catarrhal forms, is favoured by dampness of soil, air, and dwellings, and a notable reduction in the death-rate has followed the lowering of the ground-water by improved drainage; but the tables compiled by Dr. Ogle, showing the comparative mortality from phthisis and from other diseases of the respiratory organs, prove beyond question that these diseases are far more directly connected with the habits and occupations of the people: bad ventilation of dwellings and workshops, and the continued

breathing of irritating dust, have more to do with the production and development of respiratory diseases than any outward conditions of site and climate.

Diphtheria is connected with insanitary conditions, as is **enteric or typhoid fever,** but in the latter the seasonal prevalence is greatly influenced by the movements of ground-water.

Elevation.—There are no places in these islands of sufficient **elevation** to permit of the full effects of diminished atmospheric pressure and rarefied air being felt as they are in the Swiss health-resorts of the Engadine, or Davoz Platz, where above the region of rain-clouds people can bask in the warmth of the sun's rays (which are unchecked by atmospheric moisture) when the air-temperature in the shade is below freezing; in such districts the respiratory and circulatory functions, and consequently the general nutrition, are strengthened and improved. The influence of residence in hilly localities in this country is chiefly connected with the exertion incident to constant ascents of steep gradients, calling for increased action of the heart and lungs, highly beneficial under normal conditions, but in weak subjects, or when carried to excess, leading to dilatation of the heart, or to that of the air-vesicles, a condition known as Emphysema.

Aspect.—The influence of **aspect** on the comfort and healthfulness of a house cannot be denied. Generally speaking, it is not desirable that a house should stand four-square with the points of the compass, since some rooms will in that case never receive direct sunlight. As a rule, morning-rooms should face the south-east, and drawing-rooms, most used in the afternoon, the south-west. The south-west, also, is the best aspect for verandahs and terraces or conservatories, which are enjoyed in the long summer evenings. The dining-room might face south-east or south-west, according as it is used by the family as a morning sitting-room or chiefly for afternoon meals. The library should not be too dark, but strong sunshine being undesirable, it is best for it to face the north-east or north-west. The kitchen, again, should not be gloomy, and being usually the servants' sitting-room when their work in the house is done, ought to have a westerly aspect, south-west rather than north-west. Light, too, is essential to cleanliness, and should be secured for sculleries and other offices. The larder, however, which must be cool, should always be on the north or north-east, though with ample allowance of window for ventilation and light. Bedrooms will of necessity face all sides, but the night and day nurseries should face the south-east and south-west respectively wherever possible. The west and south-west walls, being exposed to the heaviest rains, may with advantage be covered with evergreens; in fact, there is no better protection against damp than ivy, the broad leaves of which

keep off the rain, and evaporate the moisture which its tendrils suck out of the porous brick and mortar. Walls well covered with ivy will always be found dry and dusty even in the wettest weather. The objection sometimes urged against ivy, that it harbours vermin, is the strongest evidence of the protection it affords against damp and cold, since it is on this account that snails and insects seek its shelter for their winter-quarters.

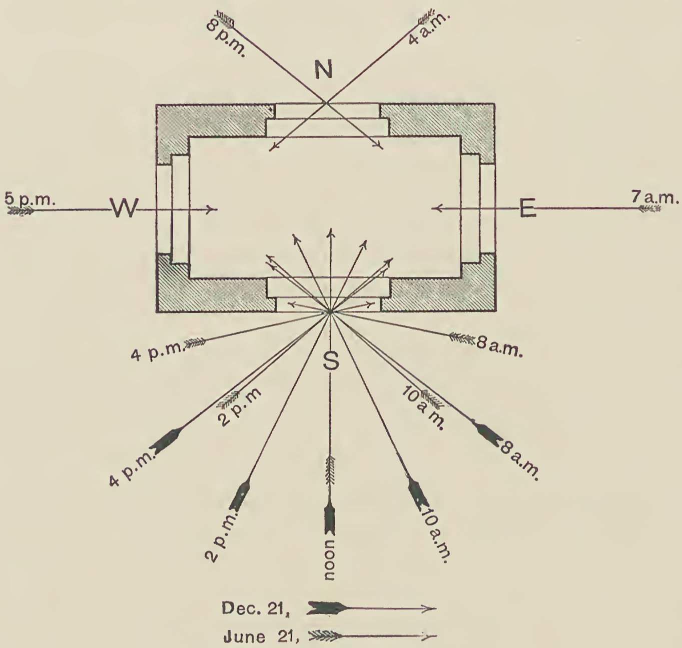


Fig. 713.—Sunshine and Aspect.

In calculating the **amount and intensity of sunshine,** falling on the walls or entering the windows on any given aspect, regard must be had to the right ascension and declination, or, in other words, the orientation and altitude of the sun at each season of the year. The former is the same in all places so long as the sun is above the horizon; the latter varies with the latitude. In the accompanying diagrams these are given for Central Germany, which is in the same latitude as the South of England; but further to the north the sun is visible for a greater number of hours in summer and for a smaller number in winter, rising and setting more to the north or the south respectively.

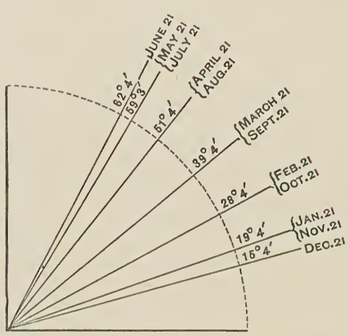


Fig. 714.—The Sun's Altitude at Noon throughout the Year.

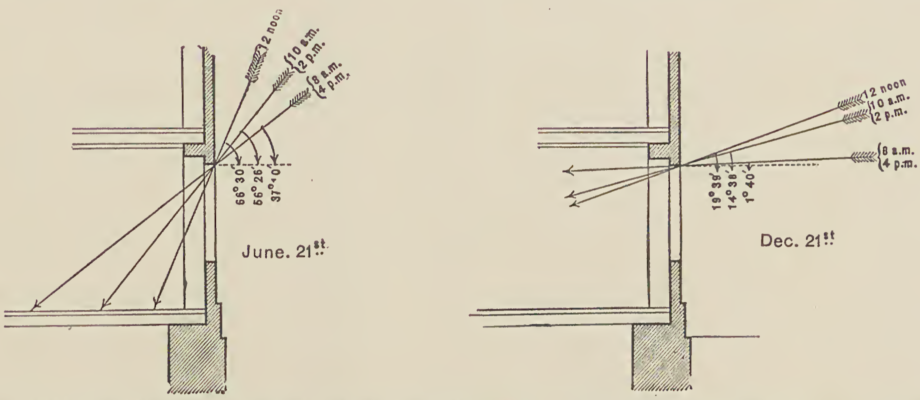
Fig. 713 shows the angles at which the sun's rays enter the windows on each side of a house standing directly north and south, on June 21 and December 21, the former being distinguished by open and the latter by black feathers to the arrows. From this it will be seen that in mid-winter the south window alone admits direct sunshine.

Fig. 714 shows the sun's altitude at noon on the 21st day of each month in the year, from 15° 4′ in December to 62° 4′ in June.

Figs. 715 and 716 show the incidence of the sun's rays in a room facing south,

every two hours from 8 a.m. to 4 p.m. on the 21st days of June and December, in the latitude of London.

Fig. 717 explains the ratio which the intensity of illumination bears to the angle of incidence, and applies alike to the intensitv of the sun's rays at different



Figs. 715 and 716.—Incidence of the Sun's rays at Noon in Window facing South between the hours of 8 a.m. and 4 p.m.

seasons of the year, different hours of the day, and different terrestrial latitudes, and also to the distribution of light in a room at different distances from the window or other source of light. It represents a number of pencils of light, a, b, c, d, and e, each including 10° of arc, proceeding from the same luminous point o, and therefore, under like conditions, of equal illuminative power. But falling on the horizontal surface m l at different angles of incidence, they are spread over spaces increasing as the tangents of the angles that the rays make with the perpendicular o m, and the intensity of illumination in the several zones will be inversely as the squares of their width. In this instance the sections f g, i k, and k l, being (approximately) as 1, 2 and $3\frac{3}{4}$, the relative illumination will be as 1^2, $(\frac{1}{2})^2$, and $(\frac{2}{7})^2$, or 1, $\frac{1}{4}$, and $\frac{1}{12}$. In the last case the angle made by the rays with the horizontal is 25°. Less, however, than 30° should not be permitted, since the light, even though derived direct from the sun or sky, will then be so dispersed that the end of the room most remote from the window will be inconveniently dark; and in this respect lofty rooms, or, rather, rooms high in proportion to their depth, present a great advantage.

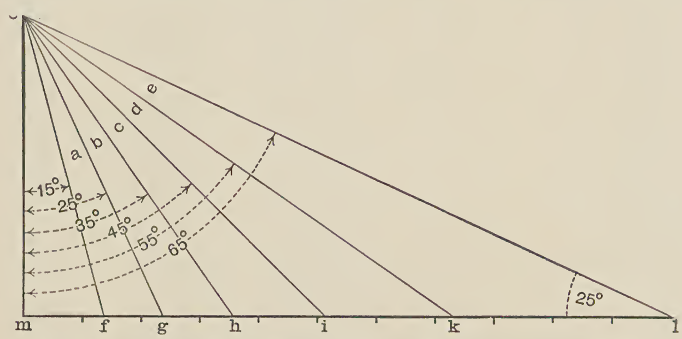


Fig. 717.—Ratio between Intensity of Illumination and Angle of Incidence.

Opposite windows equalize the illumination throughout, and even as regards schools the prejudice against "cross lighting" has little if any justification so long as the light from the right hand cannot be the stronger. Reading, and indeed any work requiring a clear vision, is nowhere so easy and pleasant as in the open air, when the sky is lightly "overcast". and the light seems to come from all sides though from nowhere in particular.

There are two other factors determining the **degree and amount of illumination** in a room, which, depending on the width of streets and the height of houses, assume great importance in town-dwellings, though they must not be ignored in the arrangement of wings and detached buildings in country houses. No room can be considered properly lighted unless the whole or the greater part of the portion in which the occupants move, receive its light direct from the sky. In towns, and wherever the view of the horizon is obstructed by buildings, trees, or rising ground, the ceiling will necessarily receive diffused and reflected light only; and it is with the aim of aiding reflection that ceilings are usually whitewashed. The nearer the tops of the windows approach the ceiling the less will be the depth of the zone of comparative darkness. The admission of strong sunshine may indeed be undesirable, and for libraries, studios, laboratories, and especially for microscope rooms, a north aspect is decidedly to be preferred, provided always that the window-space be ample, and a wide expanse of sky visible throughout the chamber. But in all rooms used for living, reading, writing, needlework, &c., the plane dividing the upper zone of diffused and insufficient from the lower of direct and sufficient light should be above the heads of the occupants, or at least above their work.

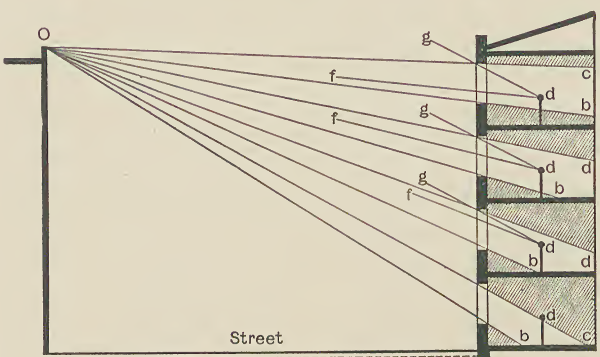


Fig. 718.—Light and Shade in the several Stories of a House.

The distribution of light and shade in the several floors of a house situated in a street which is a little wider than the height of the houses on either side, is shown in fig. 718; the third and fourth stories are seen to be adequately lighted, but the second and lowest inadequately—especially the ground-floor.

The other factor—which Prof. Förster of Breslau, borrowing a term from optics, calls the "angle of aperture"—is determined by, or is a measure of, the vertical height of the portion of the sky visible at the centre of the floor, or, as I would rather put it, by a person seated at a table in the middle of the room.

In fig. 718 it is indicated by the lines f d and g d, drawn respectively from the summit of the opposite buildings, and from the head of the window, to the point in question. In this figure it is seen to be ample on the top floor, less on the next two, but non-existent on the lowest, in which the head of the worker is in the zone of shade, and sky-light can be enjoyed only by sitting close to the window. In a basement room, even this could be obtained only by means of a wide area, if at all.

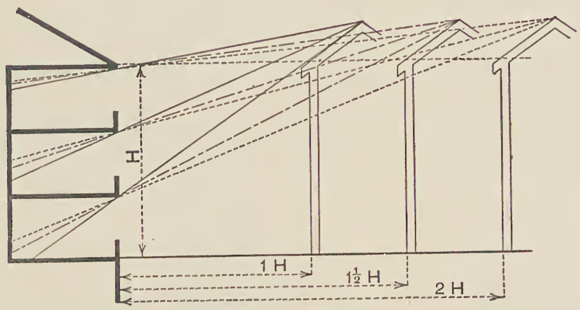


Fig. 719.—Influence of Width of Street on Illumination of Rooms.

Fig. 719 shows the distribution of light and shade, without regard to the angle of aperture, in the ground, first, and second stories of houses, the heights of which are to the width of the streets as 1 : 1, 1 : 1·5, and 1 : 2 respectively. It shows also the improvement of the illumination of the lower rooms with the widening of the street.

Town-Houses.—The light and air of **cellars** and **basement-rooms** must not be forgotten. If the entire site of the house be laid with concrete or asphalt, and the walls and footings to the ground-level protected from damp, one great objection to underground rooms is removed; but when such are occupied continuously—whether as living rooms, kitchens, offices, workshops, warehouses where packing is carried on, or indeed otherwise than as mere cellars for coal, beer, or wine,—they should be brought under the same regulations respecting light and air as over-ground floors; and the diagonal, whether at 45°, or as at present permitted in the Metropolis at 63·5, with the ground, should be drawn to the sills of the basement windows, and not of those of the ground-floor. This would necessitate the excavation of wide areas in the rear, and would preclude the practice of building a roof over the yard, which is often allowed, though it converts the ground-floors into back-to-back buildings, and consequently adds considerably to the difficulty of ventilation. The requirements of the London Public Health Act, 1891, Sec. 96, are a considerable improvement on those of the corresponding Sections 72 and 74 of the Public Health Act, 1875, in force elsewhere, though they are to a great extent nullified by the exemption of underground rooms which are occupied together with any other apartments in the house.

Again, all regulations as to the number of square feet to be left vacant in the rear of a building are futile, unless the **free movement of air** along the entire

length of the block is ensured; the so-called open space in the rear of some aristocratic "mansions" or block-buildings is really nothing but a well. For like reasons, squares, quadrangles, and courtyards, surrounded by buildings on all sides, should have openings—not necessarily thoroughfares—at the corners to permit free circulation of the air.

Streets cannot be too wide, and should never be less in width than the height of the abutting buildings, to which again a limit should be placed; the height of 90 feet to the wall-plate or eaves permitted by the Metropolitan by-laws is certainly too high, except for isolated buildings standing in extensive grounds,

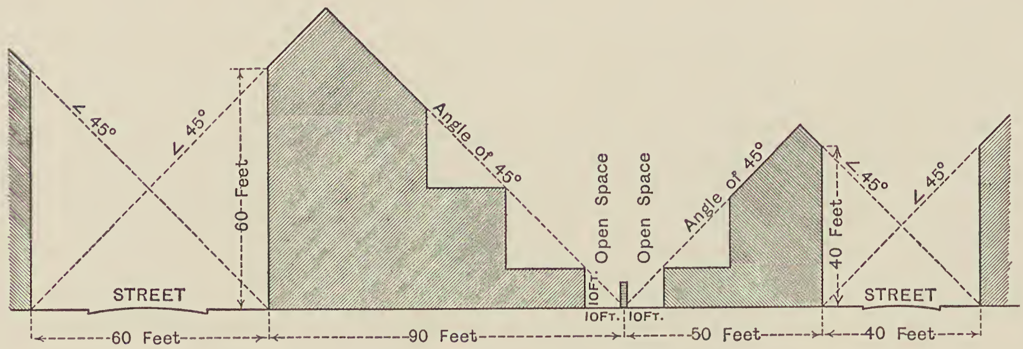


Fig. 720.—Diagram illustrating Regulations for New Houses in Liverpool.

or for factories and warehouses. Fig. 720 shows the requirements of the regulations adopted for new buildings in the residential streets of Liverpool, and recommended in the Metropolitan Bill as originally drafted. The height of the houses, it will be seen, is not to exceed the width of the street, nor in any case to be above 90 feet from the ground to the top of the walls; while a line drawn from the ridge of the roof to the foot of the wall of the opposite houses, or in the rear to that of the wall or fence dividing the backyards of contiguous houses, is to make an angle of no more than 45° with the ground, which is, in fact, that obtainable in a street where the height of the walls does not exceed its width, and the pitch of the roofs is not more than 45°.

The paving of streets has an important effect on the health and comfort of householders in towns. A perfect paving should present a surface sufficiently hard and smooth to reduce the friction of passing vehicles to a minimum, while at the same time affording the requisite foothold for horses; it should be durable, not wearing into furrows and depressions, or crumbling into dust; impervious to moisture, easily cleansed, and sufficiently elastic to be nearly noiseless. Such an ideal has not been, perhaps never will be obtained, but the nearest approach is likely to be found among the asphalts or concretes, the chief defect of which

is their "greasiness" when neither quite dry nor thoroughly wet. Granite cubes are durable, but the noise of traffic over them is intolerable in residential quarters. Wood paving when first laid seems perfect, but it is not lasting and, in spite of treatment, is too absorbent, often emitting in hot weather a perceptibly ammoniacal odour. Macadam, though suitable for country roads and quiet suburban streets, is wholly unfit for the lines of heavy and ceaseless traffic. The practice of repairing such roads with gravel and flint is bad, since crushed flint has no tendency to consolidate; for country roads at any rate, limestone is even better than granite, becoming compressed under the traffic into a mass almost resembling concrete. The more frequently and thoroughly a macadamized road is swept, the less the wear and tear and the total quantity of detritus removed in a given time.

For **foot-ways** the Imperial, Victoria, and other artificial stones are good materials, now being largely used in preference to York flags, which, as is implied in their name of *flag*-stones, are given to *flaking*, especially after frost. Asphalt and concrete laid *in situ* are, in some respects, excellent materials for foot-ways; they are practically jointless, and therefore present an even surface easily cleaned, and from which rain rapidly runs off. This very continuity of material has, more especially in the case of concrete, a counterbalancing disadvantage, namely, the difficulty and expense of taking up the pavement when required for laying or repairing the mains for gas, water, and electricity, and the still greater difficulty and expense of making the pavement perfect again.

In London and the majority of large towns, Bristol being the most notable exception, the **ventilation of the sewers** is effected wholly or in great part by gratings in the roadway, under which trays of charcoal were suspended (with the view of absorbing noxious gases) until their uselessness was recognized. There is no denying that these grids occasionally emit offensive odours, but their closure would only lead to the sewer-gases forcing an exit through traps or gullies, perhaps into the very houses. Moreover, the air of a well-ventilated sewer is nearly odourless; offensive gases are in all cases the result of putrefying deposits, and their occurrence calls for the removal of the deposits, or of the structural defects causing them. Should smells be given out from the gullies in the gutters, as not infrequently happens during prolonged droughts, all that is required is to pour in a few pailfuls of water to restore the seal of the trap.

Country-Houses.—In the country nothing contributes so much to the picturesque appearance and enjoyment of a house, as well-grown and judiciously-

planted **trees and shrubs.** They should not actually overhang the dwelling, but should be so placed as to shelter it from cold winds and heavy rains, as well as from excessive heat. Conifers and evergreens best serve the former purpose, and deciduous trees, since they do not obscure the light in winter, the latter. Deciduous trees should not, however, be too near the house, as the fallen leaves foster dampness in the soil around; evergreens, on the other hand, shed their leaves less heavily, and in the drier months of early summer. Woods and forests, provided they are not so near as to impede the movements of the air around the house, can have no ill effects, while they may afford protection against cold winds; and pine-woods are permissible in the closest proximity, possessing many advantages peculiar to themselves, with few or none of the usual drawbacks. Plants obtain from the carbon dioxide of the atmosphere all the carbon required for building up woody fibre and forming starch and sugar, the oxygen evolved in the fixation of the carbon—a process carried on in the green cells under the influence of light—more than compensating for the converse changes involved in their respiration properly so called; the net result is the purification of the air for the maintenance of animal life.

Sites near rivers are as a rule undesirable for permanent residence, on account of dampness of soil, exposure to mists, and—when the river winds through deep valleys between steep hills or cliffs—want of free movement of the air and perhaps also of sunshine, while all river-side sites are exposed to the risk of floods. The dampness of the soil depends on the elevation above the level of the water, and if this be 15 feet or over the objection disappears. Water-side houses should not be nestled in trees, and when built in a valley, the sunnier side of the valley should be chosen. The foot of a hill with a northerly aspect would be the worst possible site for a dwelling, especially if in a bend of the valley shutting out the morning and evening sun.

Sites near highways are often rendered unpleasant or even unhealthy, especially in summer, by the dust and noise created by motor traffic. The dust from roads contains dried particles from the droppings of horses and other animals, and is not only a source of domestic inconvenience, but may cause serious irritation of the throat, nose, and eye. A preparation of tar and other materials, applied to macadamized roads, certainly reduces the dust for a time.

The health-giving influence of sea-air, whether due to the presence of ozone and the absence of germs, or to factors at present unknown, is beyond doubt; but the site of a **sea-side house** should be beyond the reach of or sheltered from the direct impact of the spray, and the outer surface of the walls should be rendered impervious, since they are apt to become saturated with salt, which

keeps them constantly damp; the foot of a cliff is always unhealthy, as are the low alluvial shores of an estuary where the fresh and salt water meet, and the retiring tide leaves an expanse of mud.

Nuisances.—Trades and manufactures from which noxious gases are given off may be injurious to the health of the surrounding population, or may be merely offensive to the sense of smell. They are alike the subjects of legislation, but too often (the enforcement of the Acts being intrusted to local authorities in which the manufacturers have frequently a preponderating influence) the law becomes practically a dead letter; besides, there is no legal or authoritative definition of what constitutes in each case "the best available means" of obviating the nuisance. Many trades are injurious to the health of the operatives themselves, but not to that of the neighbourhood; with these we are not here concerned. Those that are public dangers are chiefly of a chemical kind. Hydrochloric acid is emitted from alkali-works and also from potteries during the process of salt-glazing. Chlorine is largely produced in bleaching-works and in the manufacture of bleaching-powder, the so-called chloride of lime. In the roasting of certain ores, consisting for the most part of sulphides of copper and lead, sulphurous acid and arsenical vapours are passed into the air, and in the emanations from vitriol-works nitric acid is also present. The latter is also evolved in the production of aniline colours, while sulphuretted hydrogen and ammonium sulphide are emitted from gas-works, and in the manufacture of sulphate of ammonia and other chemicals, and in enormous quantities from the spontaneous decomposition of alkali-waste. All these gases are most injurious to health when inhaled in the concentrated forms in which they are met with in chemical and alkali works, potteries, and many other industries in which lead, arsenic, mercury, &c., are employed, but the consideration of these belongs rather to factory and industrial hygiene, which is beyond the scope of this work. In the small quantities in which they are present in the general atmosphere their injurious effects are most evident in the destruction of vegetable life around the great centres of industry, although they cannot but exert a deleterious influence on the health of the population. Such acid gases and vapours in the air act as irritants on the mucous membranes of the respiratory passages, and to them as well as to the presence of sulphuric acid from the combustion of coal and gas in towns, is doubtless due the greatly increased prevalence of late years of naso-pharyngeal catarrhs and polypi. The sulphides of hydrogen and of ammonium tend to impoverishment of the blood, and arsenical vapours to catarrhs of the eyes, bronchi, and the alimentary tracts, as well as to irritation of the skin, but these are rarely experienced

outside factories, except as a result of arsenical pigments in wall-papers and other decorations, such as artificial flowers.

Among trades which, though not proved to have any deleterious effect on the health of the neighbourhood, are **nuisances** in consequence of the offensive odours they emit, may be enumerated those of the tanner, fell-monger, gut-scraper, blood-boiler, glue-manufacturer, tripe-boiler, soap-maker, tallow-boiler, fish-manure and superphosphate manufacturer, chemical manure-works of all kinds, and fried-fish shops. Brick-fields, too, are in some places nuisances from the smells given off by the refuse used to burn the clay, and cement-works, though usually isolated and in the open country, evolve highly acrid fumes. The smoke emitted from factory and other chimneys may be a very real nuisance, though of a different kind.

Sewage-farms on unsuitable soils, or under careless or unscientific management, often constitute grave nuisances, but it is quite certain that sewage-farms, properly designed and managed, may be absolutely inoffensive. They are so at Berlin, where asylums, schools, and gentlemen's houses have been erected everywhere in the vicinity. Since, however, there can be no assurance that a sewage-farm will never be mismanaged, and since it is extremely difficult under certain conditions of wind and weather for even the best manager to prevent objectionable sights and smells, the house-hunter will act wisely in avoiding the too close proximity of such an outlet for putrescent matters.

CHAPTER III.

WATER.

The vapours rising from sea and land are condensed into **rain** on meeting with currents of cold air, or impinging on mountain-tops. When first formed the rain differs little, if at all, from distilled water, but in its fall it takes to itself various gases and suspended matters from the air. On reaching the earth, part is evaporated and part absorbed, the proportions varying with the perviousness of the soil, and with other conditions; if the rainfall be heavy and the face of the land inclined, and especially if the soil be rocky or plastic, much runs off as storm-water to the nearest stream or lake. Of that which is absorbed, part is taken up by the roots of trees and plants, to be again evaporated from their leaves; but the largest portion sinks downwards until,

meeting with some impervious stratum, it forms a sheet of water, filling the interstices between the particles of the soil. This is the "ground-water", to which reference has already been made. In some localities it is nearly stagnant, rising and falling with rain and drought; but usually it flows slowly onwards, following the decline of the impervious stratum which forms its bed,—and which, by the way, need not correspond with the surface-contour,—until it finds an exit as a spring or enters the channel of a river. During its course through the soil it takes up everything organic, inorganic, or gaseous, capable of being dissolved.

The **mineral constituents** of all waters take their character from the nature of the beds through which they have percolated. The most important are the carbonates, chlorides, and sulphates of potassium, sodium, calcium and magnesium among the alkalies and alkaline earths, and of iron among the metals. Magnesium and iron are found only in certain localities, and iodides, bromides, lead, arsenic, &c., still more rarely. These, as well as the chlorides, and sulphates of sodium and magnesium, when present in amounts rendering the water unfit for ordinary household use, constitute it a medicinal water. Calcium and magnesium salts give hardness, and an excess of chlorides, as in salt water, has a similar effect.

"**Aëration**" is an equivocal expression. Water exposed to the air absorbs its constituent gases, though in different proportions, oxygen being far more soluble than nitrogen. Water in the soil absorbs the ground-air, in which carbon dioxide (CO_2) is present in proportions enormously in excess of that found in the atmosphere. The so-called aëration of spring-water is therefore very different from that of river-water: the "air" contained in the latter is composed largely of oxygen, and will support the respiration of fishes, but that in spring-water consists mainly of carbon dioxide, which is irrespirable. In the small quantity in which the latter usually occurs, it is the product to a great extent of the decomposition of organic matter, but the carbon dioxide in such mineral waters as Seltzer, Johannis, &c., has a different origin. However derived, it imparts to the water the power of dissolving carbonate of calcium, or chalk, by which the water is rendered "hard".

Hard waters are incapable of producing a lather with soap, until the whole of the lime present has been used up in combination with the fatty acids of the soap. The effect of boiling hard water is, by expelling the free CO_2, to throw down the carbonates of lime, and of magnesia should any be present, rendering the water soft, but depositing in the kettle or boiler, as well as in hot-water pipes, a crust composed of impure earthy carbonates, which may

easily be dissolved by a weak acid, as vinegar or dilute hydrochloric acid. So much of the hardness as is due to the presence of calcium and magnesium carbonates, and is removable by boiling, is called "temporary hardness", but since other salts, as chlorides and sulphates, cannot be thus precipitated, the hardness they cause is called "permanent". Very hard waters, as those from the chalk, are softened on a large scale by adding so much "milk of lime" as shall, by combining with the free CO_2, be converted into carbonate, when the chalk previously in solution, together with that thus produced, falls as a sediment, and the clear and now much-softened water is pumped or siphoned off.

All water that has percolated through the soil contains chlorides, chiefly sodic chloride or common salt. The quantity in lakes and rivers is generally less than in springs and wells, since the former are more or less fed by storm-waters, and rain that has not penetrated the soil.

In the economy of nature all **organic matters**, carcasses, excreta, &c., soaking into, or buried in the upper soil, undergo decomposition through the action of bacteria. These swarm in the superficial layers to the depth of a few feet, but are not found at greater depths. They are absent from pure sand, chalk, rocks, and plastic clay, but appear in these so soon as, by digging and the admixture of other earths and manures, they are converted into "soil". Thus, sewage-farms in poor sandy districts, as those of Berlin, are rendered more efficient by the constant incorporation of the sludge. Light friable sandy loams are by far the best purifiers; but even in them the "top spit" is the most active, the number of bacteria rapidly decreasing downwards, until below six or eight feet they have practically disappeared. This upper zone has been well described by Dr. Poore as "the living earth", all below being "dead", or devoid of active living organisms. Putrefaction is effected by other bacteria, and is attended by the evolution of stinking gases (ammoniacal compounds with sulphur and phosphorus), but in the decomposition under consideration the agents are the so-called "nitrifying bacteria", by which the albuminous matter and these ammoniacal products are further oxidized into nitrous and nitric acids, which combine with the earthy bases in the soil to form nitrates, and in that form furnish the principal food of plants; this process, in fact, is that on which the whole theory of manures is based, the conversion of animal substances into mineral salts, which alone plants can absorb and transform into vegetable albumen, &c.

But if organic matter be buried too deep, or passed too rapidly into the dead earth, or if the living earth be taxed beyond its power, **water charged**

with putrid matters may percolate for hundreds or even thousands of feet in any direction without undergoing any real purification: the coarser particles, may be arrested, but the dissolved matters remain unchanged. In this lies the danger of cess-pools and grave-yards, by which sewage and putrid matters gain access to the ground-water at such a depth as to escape the action of the nitrifying bacteria of the upper soil; whereas sewage and excreta dug into highly cultivated surface-soil are so completely and rapidly "mineralized", as the French say, that no trace of organic matter, as such, can be found in the ground at a depth of from four to six feet. This has been conclusively proved by Dr. Poore in his own garden at Andover.

Potable Waters.—**Potable waters** may be divided into rain, moor, river, lake, pond, marsh, spring, surface-well, and deep-well waters, those of each class differing much in their composition and characters.

Rain-water collected in the open country is very pure and aerated, though from the absence of CO_2 not sparkling; but if collected on roofs it may contain much mineral and organic matter, and in or near towns soot, sulphuric and hydrochloric acids, &c. Close to the sea it may even be salt from the spray carried by strong winds.

Moorland-waters are collected, by impounding, for the supply of towns in the northern counties of England, in Devonshire, and Wales. They are as a rule pure, though containing more inorganic and organic matter than rain-water; but when they have percolated through peat, they take up certain organic acids which exert a solvent action on lead pipes, and, as at Sheffield, Leeds, Bacup, Batley, and elsewhere, this may give rise to lead-poisoning. The best preventive measure in such cases is to treat the water with lime, in fact to harden it. The lime neutralizes the peaty acids, and by forming on the surface of the lead an insoluble coating, protects it from the solvent action that all pure soft aerated waters possess in a greater or less degree.

Lakes in mountainous countries, as Wales, Cumberland, and the Scottish Highlands, yield the purest and most abundant supplies, provided they be not stained with peat. They are purer than moorland-waters, since the collecting areas are largely composed of bare rock, suspended matters of all kinds are deposited in the bed of the lake, and the small amount of organic impurity is removed by the animal and vegetable life in the water. Contrary to what might have been expected, many lake-waters, as those of Bala, Thirlmere, and Loch Lomond, appear to have little or no action on lead.

Lowland lakes and ponds, in the midst of cultivated and populous districts, are wholly unfit for potable purposes, being fed by storm-waters and surface-

drainage charged with organic impurities. This condemnation does not apply to such as are not exposed to these dangers. The Tegel and Müggel See, from which Berlin now derives its supply, situated in sandy plains, surrounded by pine forests and remote from human habitations, and those supplying Dantzig and other towns in northern Prussia, are fully equal to the mountain-lakes already mentioned.

Springs rising on hillsides, and **upland-streams** impounded near their sources, may be considered as moorland-waters that have been subjected to a process of natural filtration and purification by the bacteria of the upper earth. They may be slightly hard, but furnish waters of exceptional purity.

Rivers for the most part owe their origin to such springs and streams, or to the overflow of mountain-lakes, but as they proceed seawards they receive an enormous accession to their volume from springs, affluents, surface-drainage, and storm-waters, together with the sewage of towns, river-side houses, and barges. The purity of rivers is to a great extent dependent on their length and volume. The Rhine at Bonn, for example, though it has traversed populous regions for several hundred miles, exhibits a freedom from pollution that could not have been expected from the size and number of the towns on its banks, and on those of its tributaries. We are thus brought face to face with the vexed question of the so-called "self-purification" of rivers. Of the reality of the phenomenon itself there can be no doubt, but its extent has been much overestimated and its nature misapprehended. It is not simply the effect of oxidation by continued exposure to the air, but it is the result of a complex process including not only aeration and subsidence, and dilution with affluent streams, ground-water, and springs, but also the action of animal and vegetable organisms—fish, entomostraca, plants, and bacteria. It is in many respects analogous to what has been described as taking place in the living earth.

Rivers flowing through alluvial deposits always contain a certain amount of suspended matters, chiefly clay, which may even render filtration difficult, and after floods they are often turbid with mud brought down by storm-waters, or lifted from their beds by the violence of the current. Chlorides are usually more abundant than in spring-waters or lakes, the excess being due to the presence of sewage, which is indicated also by ammonia and the so-called albuminoid ammonia, or organic matter in a crude state. As a general rule rivers are not to be recommended as sources for the public supply of towns, a fact which is yearly becoming better recognized in all civilized countries, though filtration may do much to render such waters fairly pure and safe. At the same time, it must be admitted that no ill results have been traced to the use of the Thames

water in London, since the intakes were removed to above Teddington weir, where the tidal currents cease to be felt.

Surface-wells—which need not be shallow as measured in feet—are such as are sunk, in a pervious surface-soil, to the ground-water resting on the first impermeable stratum. They are always to be viewed with suspicion, for though the surroundings may be faultless, and all organic matter nitrified before reaching the level of the water, this may be contaminated at some point in its course thither, as by cess-pits leaking at a depth where soil is dead, or by a straw-yard or dunghill, the earth beneath which is so saturated with impurity as to be powerless to nitrify the organic matter. Those wells in which the water rises nearly to the surface, are specially dangerous. In short, the conditions under which alone a surface-well may be considered unobjectionable, are that the soil shall be of a kind to purify the water sinking through it, that the level of the ground-water be at no time less than six feet from the surface, that no source of pollution exist within some hundreds of yards (especially in the direction from which the water flows), that the sides of the well be absolutely impervious for a depth of at least eight to twelve feet, that surface-water and dirt be excluded by a parapet about eighteen inches high and a stone slab covering the mouth of the well, and that the water be raised by a pump, and not by buckets, which are frequently the means of fouling it. The plan—first suggested, I believe, by Dr. Woodforde, Medical Officer of Health of Berkshire—of lining surface-wells by a series of large glazed stoneware sewer-pipes placed one over the other with the flanges downwards, well jointed with cement, and backed by a layer of concrete on the outside to give additional strength, is much to be preferred to the porous brick-and-mortar steining commonly used.

Deep wells are those which, passing through one or more impervious beds, tap a sheet of water in some lower stratum, which has percolated along it from its outcrop on hills or higher ground at a considerable distance. They may be dug and steined, or bored, or dug to a certain depth, below which they are continued by boring. It is always advisable to leave the tube *in sitû*, and the steining should be constructed with special wedge-shaped vitrified bricks set in cement-mortar. If common rectangular bricks have been used, they should be faced with cement, down at least to the level of an impervious stratum not less than twenty feet from the surface, so as effectually to exclude any land-springs or surface-water, by which the water in the well might be contaminated. Even when sunk in hard rock, the lining should not be omitted, for these wells are especially liable to the entrance of polluted surface-waters; above all, wells sunk in the chalk are exposed to such risks, from the passage of polluted waters from

cess-pits, &c., through the fissures by which this formation is everywhere traversed.

Deep-well waters are usually hard; those in chalk or limestone from carbonate of lime, in the dolomite from lime and magnesia, and in the lias and some oolitic beds from chlorides, sulphates, &c., which may render them actually unfit for drinking, or give them the character of medicinal and aperient waters. Those, however, from the chalk, mountain-limestone, upper oolite, and coal measures, are among the very best, though all more or less hard.

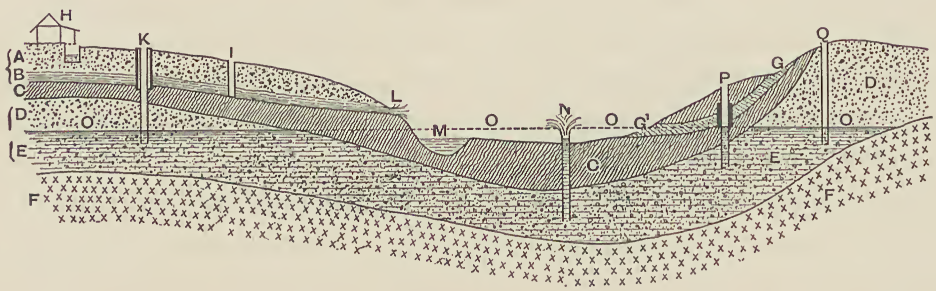


Fig. 721.—Diagram showing ground-water, deep water, spring, stream, and different kinds of well:—

A. A superficial bed of pervious sand or gravel.
B. Ground-water emerging at L as a spring, which finds its way to the stream M.
C C. An impervious bed or stratum of clay.
D D. A deep pervious bed of limestone or sandstone, forming in its lower part a large subterranean sheet or reservoir of water, E E, the level of which is O, O, O, O.
F F. An impervious formation of solid rock supporting the mass of water, E, in the pervious bed, D.
G G′. A seam of gravel traversing the bed of clay, C, receiving the surface drainage at G, and giving rise in wet weather to a so-called land-spring at G′.
H. A house with privy and cess-pit, which may pollute the ground-water, B.
I. A *surface*-well sunk into the ground-water, B.
K. A *deep* well, steined as far as the clay so as to exclude the ground-water, and tapping the subterranean water, E.
N. An *artesian* well, in which, the mouth being below the line O, O, O, O, the water rises under pressure in the form of a natural fountain, requiring no pump as all the others do.
P. A *deep* well steined to exclude the land-spring in G G.
Q. A well which, though drawing from the same source, and at the same depth as P, is technically a *surface* well, since it does not pass through any impermeable stratum.

Through a pedantic ignorance the term "**artesian well**" is almost constantly applied to machine-bored wells, whereas it properly describes a peculiar form of deep well from which the water rises up in a natural fountain; the name is derived from the French province of Artois, where the phenomenon was first observed. The requisite conditions are rarely met with, viz. a hollowed, saucer-like bed of clay overlying pervious, water-bearing rocks, the lowest point of the depression being below the level of the ground-water in the surrounding strata. Given these conditions, it follows that as soon as the dense bed in question is pierced, the water spouts upwards under its own pressure.

Far too much reliance is placed by the public on the results of a **chemical analysis** of water. Because in his examination into the proportions in which certain constituents of nearly all waters are present, the analyst finds no evidence of sewage pollution in that particular sample, the character of the water is supposed to be conclusively vindicated. This is, however, a dangerous error. From what has been already stated, it will be easily understood that all ammonia, or material convertible into ammonia (by boiling with an alkaline permanganate), and known technically as "albuminoid ammonia", is evidence of the presence of organic matter in the process of change, while nitrites indicate a further, and nitrates the ultimate stages in the conversion. Nitrates themselves are quite harmless, but when they are associated with nitrites, and saline and albuminoid ammonia, the continuity of pollution—as distinguished from one long-past, or a single and accidental contamination—is demonstrated. Chlorides, if exceeding 15 parts of chlorine per million parts of water, are very generally accepted as evidence of sewage pollution recent or remote, but it should not be forgotten that in some springs, as those of the natural medicinal waters, chlorides, however abundant, may be wholly of mineral origin. It is quite true that from a consideration of the chlorides, nitrates, nitrites, ammonia, and albuminoid ammonia, and the oxygen required for the complete oxidation of the cruder organic matters, the chemist may form a notion as to the amount, nature, and age of the pollution, and whether it be continuous or a thing of the remote past; but unless he has a fair knowledge of the geology and hydrology of the district, the general character of its waters, the density of the population, and the nature of its manufactures, and is acquainted with the surroundings of the well or spring, he had far better confine his report to a mere statement of percentages and of the physical character of the water, leaving all expression of an opinion as to its wholesomeness to those who have the wider knowledge and are familiar with the local conditions.

But **the greatest dangers in water** are beyond the power of analysis to recognize: a single cholera or typhoid evacuation discharged into a reservoir may set up an epidemic, though from its extreme dilution all the resources of chemistry would fail to detect it. Public-health records abound with such cases. It is not organic matter as such, nor matter in a state of putrescence; it is not even fæcal matter in itself, that constitutes the real danger. Such pollution may or may not affect the digestion or induce diarrhœa; indeed it frequently happens that people have for years drunk with impunity a water containing palpable amounts of excrement. But the indication of such organic or fæcal pollution is a danger-signal, for if healthy evacuations have gained access to the

water, those of diseased persons may do so too, and the use of the water must be absolutely prohibited until the pollution has been stopped without possibility of renewal.

Some useful information is furnished by an ordinary **microscopical examination** of the sediment or suspended particles in water, whether inorganic (as sand, chalk, or clay) or organic (as vegetable débris, or the undigested fibres and cells contained in excrement), or living animal and vegetable organisms. Some of these organisms are constantly to be found in running waters and lakes of a high degree of purity, to the maintenance of which they may even contribute, but others are present only or chiefly in polluted waters, the organic matter in which provides their nourishment.

No report on a water can be considered complete or satisfactory without a **bacteriological examination,** which may be confined to an estimation of the number in a cubic centimetre of the water, proved to be living by their development under cultivation into separate "colonies"; or may be extended so as to include the endeavour to determine the presence of those known to be the cause of certain diseases, or to be constantly associated with them. In making the latter examination, any suspicious forms are transplanted, and what are called "pure cultures" made, and subsequently submitted to various staining processes by which they may be more positively identified.

But after the most exhaustive examination, chemical and biological, it must be remembered that the result applies only to the water at the moment when the sample was taken; that negative evidence as to bacteria means only that particular forms were absent from the few drops examined; and that pollution may occur at long and uncertain intervals. Hence the necessity for an **inspection of the surroundings,** and a knowledge of the nature and structure of the soil, as well as of the direction of the flow and the fluctuations in the level of the ground-water. A rise of the ground-water, a single heavy fall of rain, and many an accidental occurrence, may lead to the fouling of a source that had maintained its purity for months or years. All such possibilities must be excluded before a supply can be pronounced absolutely and permanently safe.

The bottle used for taking a **sample of water for analysis,** should have a capacity of about half a gallon, and be perfectly clean; it should be either new, or one that has contained a mineral acid which can leave nothing adhering to the glass; such a bottle can be had of any chemist. It should be stoppered or closed with a new and clean cork. If the water to be examined be that of a well, the pump should be worked for a minute or two before the sample is taken; if from a public supply, the tap should be left running for at least three to five

minutes, unless the question to be answered be its tendency to dissolve lead from the pipes; and if the water be that of an open or bucket well, or of a river or lake, the bottle should be plunged some distance below the surface. In every case it must be repeatedly rinsed out with the water to be analysed before being finally filled, then sealed and forwarded without delay.

For bacteriological examination a much smaller quantity—a few ounces—will suffice, but the absolute cleanliness of the bottle is even more necessary; to ensure this it must be sterilized by being plunged open in boiling water for five minutes, and the stopper reinserted directly the bottle is taken out. Prompt delivery of the water is imperative, for if many hours be allowed to elapse, especially in warm weather, the bacteria may undergo a material increase in number.

Section XIX.—STABLES AND COW-HOUSES

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SECTION XIX.—STABLES AND COW-HOUSES.

CHAPTER I.

STABLES.

In no country so much as in Britain is the horse at once the friend and the companion of man, and in no country is he so well housed. The arrangement and the construction of a gentleman's stable are of an importance second only to that of the dwelling-house itself; indeed, it is to be feared that in some cases the accommodation provided for his equine servants claims more thought and care than that provided for his human ones.

In selecting a position for the stables, something of course will have to be left to the special exigencies of the site, but a few general principles may be laid down. While naturally taking somewhat of a rearward position, they should be easy of access from the front entrance and approach. It is not perhaps desirable to have them in too close juxtaposition to the domestic servants' yard and offices, but they should be of easy access from the master's office or study, and from the side entrance used by the master of the house and his family. As it is not desirable to have too many back lanes or approaches likely to be neglected, or to form a loitering-place for idlers, it may be well to arrange the stable entrance so as to be at the same time accessible from the main carriage-drive, and yet available for such purposes as the removal of manure, &c., without such operations being unduly in evidence.

Considering the importance of the stable department, it would seem proper to give it a fair amount of **architectural embellishment,** always bearing in mind, however, the sound maxim, that utility is the cardinal principle in all building, and that the truest architecture is the artistic treatment of the useful. Whatever style is adopted in the dwelling-house should be applied in a plainer degree to the stables. The material, so far as it affects the internal fitting up, will be more suitably dealt with at a later stage, but as regards general construction, the local materials will usually be found most suitable; brick, stone, or even

wood, may be applied, but the latter in this climate is seldom durable, except at a considerable expense in the way of periodical painting or coating with other preservatives.

In the general arrangement of a stable there are many points to be considered. The modern horse is, like the modern man his master, an artificial product, and like him is easily affected by healthy surroundings or the reverse. There are few of the principles of modern sanitation, as set forth in the earlier sections of this work, which are not also, in their degree, applicable to the stabling department. A dry and well-drained site, air, light, and ventilation without draught, are all indispensable for a healthy suite of stables. Cesspools under or close to a stable, and any large or long-standing collections of manure in close proximity, should also be avoided.

The principal accommodation required in a complete stable-range will consist of stalls, loose-boxes, one or more sick or isolation boxes, a washing-box or shed, coach-house, harness-room, cleaning and saddle rooms, a provender-room, tool-house (which may possibly also be made available for a heating-apparatus for hot-water pipes to the coach-house), and lofts for hay and corn. The last-named may be partly over the stable, as tending to keep the latter at an even temperature, but the ceiling of the stable should, as far as possible, be air-tight, as the less communication there is between the air of the stable and the loft the better. For this reason it is desirable that the ladders or stairs to the loft, and the shoots for hay and corn, should not open directly into the stable, but, if possible, be in the provender-room, or in a separate passage. It is also of advantage that a portion at least of the yard should be covered over, for the more comfortable washing of carriages, &c., in wet weather. If this be done, a special washing-box for horses may perhaps be dispensed with, though it has its advantage on the score of privacy in the case of restive horses. It is better not to have the manure-pit inside the stable-yard, but at some distance, a portable iron box being provided for the removal to it (daily or more often) of all manure from the stable. Latrines for the stable-men should form a part of every well-ordered stable.

A typical plan is shown in fig. 722, with two stables of four stalls in each, a range of four loose-boxes, a sick-box, washing-box, harness-room, coach-house, fodder or provender room, and a tool-house. As the washing-box serves also for a passage, there is a direct communication throughout the range, except in the case of the sick-box, the isolation of which is rendered as complete as possible. Perhaps four ordinary loose-boxes, especially with the addition of a sick-box, may be in a larger proportion to eight stalls than is usually the case.

Where hunters are kept, however, this number will not be too numerous, as the boxes will be used mainly for the hunters and the stalls for carriage-horses. If this is not the case, the end box can be cut off as a separate house for a root-store, or for dogs. Some persons, also, might prefer the loose-boxes to be entirely

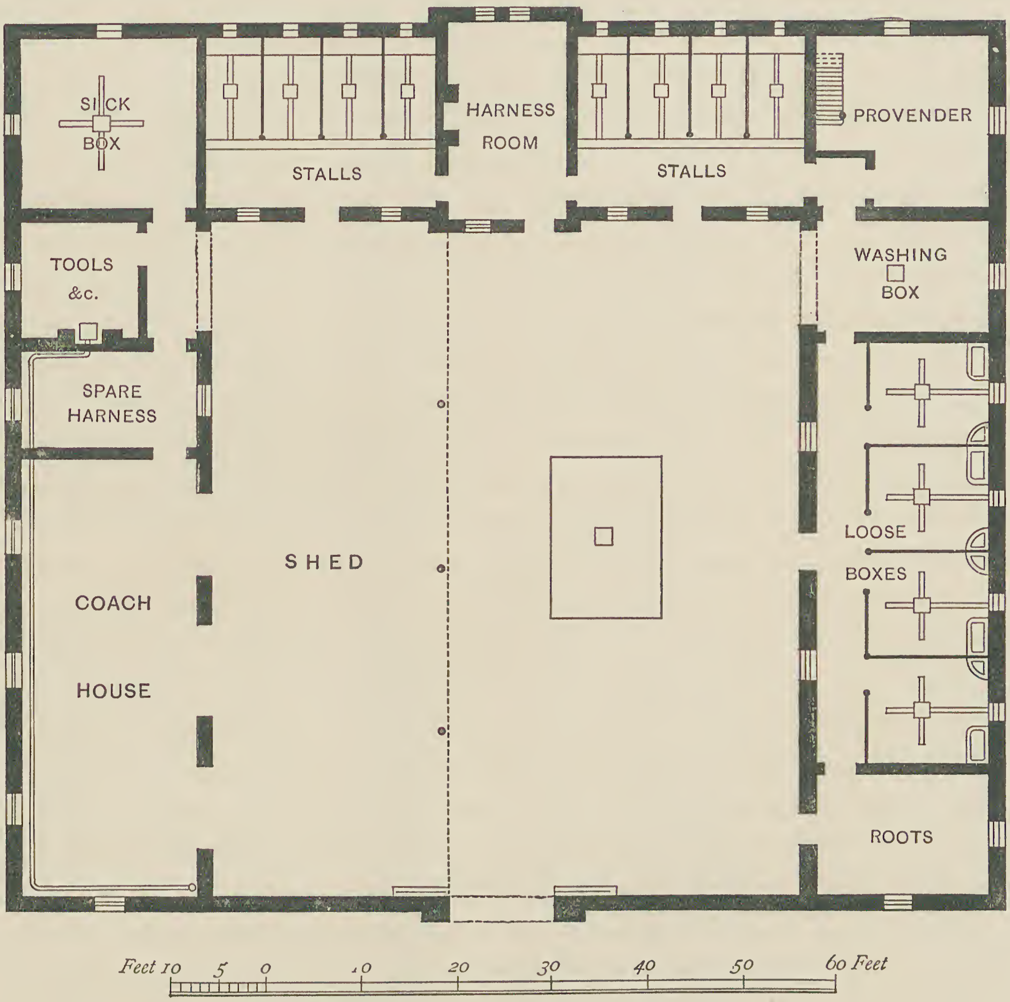

Fig. 722.—Plan of Stable-buildings for Twelve Horses.

separate, with access only from the yard; but the horse is a sociable animal, and is more comfortable within sight and hearing of his companions. The advantages also in the matter of attendance, and the increased facilities for ventilation, outweigh those of increased isolation. The covered part of the yard is shown with only three supports, the facilities for the manufacture of light iron roofing rendering a multiplicity of columns quite unnecessary. It is not desirable that anything of the nature of a residence, especially where there are children about,

should form any part of a stable-range, although in some cases this is insisted upon, but apartments for at least one attendant should be provided, care being taken that, while accessible from the stables, they are not immediately over any part occupied by the horses. The room over the harness-room is often found suitable for this purpose. It is not well to have too many stalls for horses in a single stable; ranges of four, or at the most, five, with walls and doors between, are much better both for isolation and quietness.

Smaller Stables.—The quadrangular arrangement shown in fig. 722 cannot be adopted for small stables. As a rule, the building takes the form of a simple oblong, the stable itself being at one end, the corn-store and harness-room in the middle, and the coach-house at the other end. The central portion may be carried up to a greater height than the others, in order to provide space for a hay-loft or a man's room over the harness-room and corn-store.

In many cases an L-shaped plan is the most suitable for the site, the coach-house serving to screen the stable from the garden or house. Plans of two stables of this kind are shown in figs. 723 and 724, and views of the same buildings are given in Nos. 1 and 2, Plate XXVII. The accommodation provided in fig. 723 includes a loose-box and two stalls for horses, and a smaller stall for a pony, a harness-room, heating-chamber, and coach-house; over the heating-chamber and harness-room there is a room for a man, and over the coach-house there is a large loft for hay, corn, &c. In the original design for this building, a corn-store was shown on the ground floor, two boxes were provided, and a glazed roof was shown over part of the yard in front of the coach-house. The manure-pit and earth-closet are at the back of the stables. The heating-chamber contains a boiler, which serves to warm, by means of hot-water pipes, not only the coach-house, but also a range of lean-to green-houses built against the back wall of the coach-house. Fig. 724 shows the plans of a building containing on the ground floor a small stable for three horses, harness- and store-rooms, and coach-house, and on the first floor a hay-loft over the stable and coachman's house over the other rooms. The stable and some of the other rooms were originally shown larger, but the sizes were reduced in order to bring the cost down to a specified amount, and consequently the plans cannot be regarded as entirely satisfactory. They serve, however, as an example of an economical range of buildings, and of one method of planning a coachman's house over part of the ground-floor space. Externally the two buildings, of which the plans are given in figs. 723 and 724, were designed to be in keeping with the adjacent houses.

Some of the **materials used in the construction of stables** will be treated

No. 1.

No. 2.

No. 3.

No. 4.

Nos. 1, 2. STABLES, "ASHWOOD", BYFLEET, SURREY.

" 3, 4. STABLES AND LODGE, "WOODLEA", WOLDINGHAM, SURREY.

upon in the detailed description of the several parts. With regard to the walls and roof, there is no special material that is better than another; whatever most harmonizes with the dwelling-house, or is most characteristic of the locality, is suitable. Brick, stone, or even wood may be selected. Both stone and brick

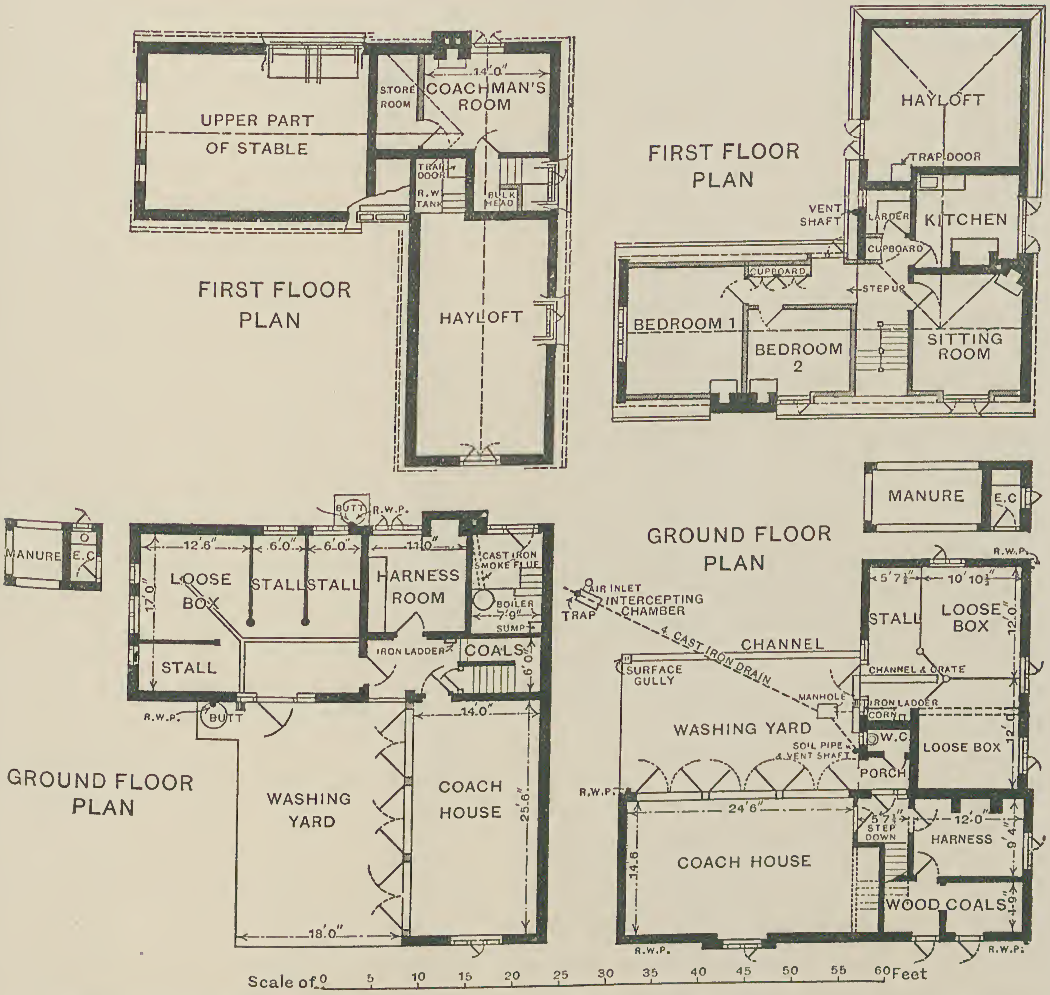

Fig. 723.—Plan of L-shaped Stables with Man's Room.

Fig. 724.—Plan of L-shaped Stables with Coachman's House.

walls can be easily kept dry by building them with a hollow space in the centre. For the roof, slates are now generally the cheaper, tiles the more picturesque.

A good stable should be eighteen feet wide inside, and each stall should be six feet wide. The divisions of the stalls should be at least nine feet long, which will leave nine feet for the passage behind the horses, or, if the stall-division is ten feet, as is better, the passage will be eight feet wide. A stable for cart-horses may be sixteen feet wide, but the width of the stalls should not be less

than six feet; narrower stalls are often made, but for large horses this width is indispensable. A good size for a loose-box is about twelve feet by ten, but boxes often vary much in size according to convenience in planning, or the caprice of the owner. The stable of olden time was a very dirty place, and amongst many stable attendants ideas and habits in consonance therewith too often still linger. In the modern stable, however, strict cleanliness is almost as much a desideratum as in a hospital ward. Everything should be clean, bright, and pleasing to the senses. The gentleman's horse is often a nervous and fidgety creature, and every part of the fittings should be so constructed as to reduce the possibility of his doing himself an injury to a minimum. There should be no sharp or projecting angles in the stall-divisions or manger.

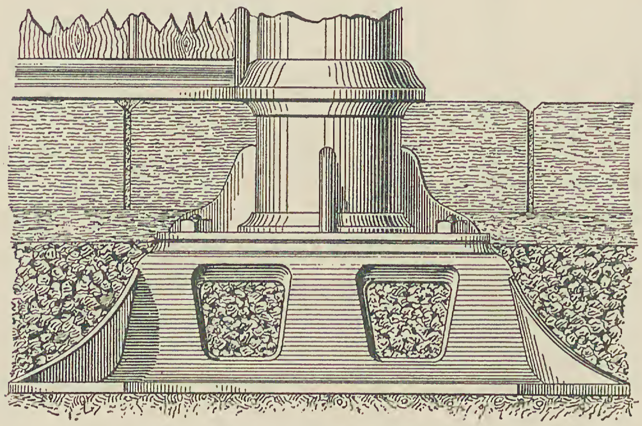

Fig. 725.—"Self-fixing" Base for Cast-iron Stall-pillar.

The stall-divisions are usually fitted with cast-iron posts, which may be bolted to a stone block, or provided with a hollow base, which can be filled with and bedded in concrete, as shown in fig. 725. A ball or other rounded top is best for safety, and a very pleasing effect may be produced by having the ball of polished brass. The divisions should be of wood, grooved and tongued, and $1\frac{1}{2}$ to 2 inches thick, sliding into a grooved iron sill below, and a curved or ramped iron capping above. A portion of the sill should be fitted, as shown in fig. 726, with a shifting-piece to allow the woodwork to slide in, for the convenience of replacing, when damaged; when the shifting-piece is replaced, it holds all secure. The divisions may be pitch-pine or oak, but a very handsome and strong division is sometimes made of teak, rubbed smooth and oiled. Many divisions have an intermediate rail, in which case the portion between this rail and the ramped upper rail may be of round iron bars, or iron trellis-work, which gives a much lighter appearance, and facilitates the circulation of air. It is better, however, that the parts immediately beside the horses' heads should be filled solid, so that the horses when feeding cannot see and possibly disturb each other. Another advantage of the central rail is that it may be made hollow to contain a sliding bar, which can be drawn out at night and the end secured to a staple or socket in the wall. This closes the passage

behind, so that, if a horse breaks loose during the night, he will be safely confined to his own stall. A typical division is shown in fig. 727, which also shows in section a hopper window serving as a ventilator over the horse's head.

The divisions for loose-boxes are generally made of the same character as the stall-divisions, with boarding below and trellis-work above, which, in the same way as for the stalls, should be closed alongside the manger, &c. The latch of the door should be flush with the woodwork, and made of such a form that the horse cannot "nose" it open. Loose-box doors may also be made to slide, but the advantage is not apparent. A simple method of forming a loose-box is by continuing one or both end stalls back to the wall, filling the space by a door and short length of stall-division. This is economical, but has the disadvantage of leaving no thoroughfare in the case of a continuous range.

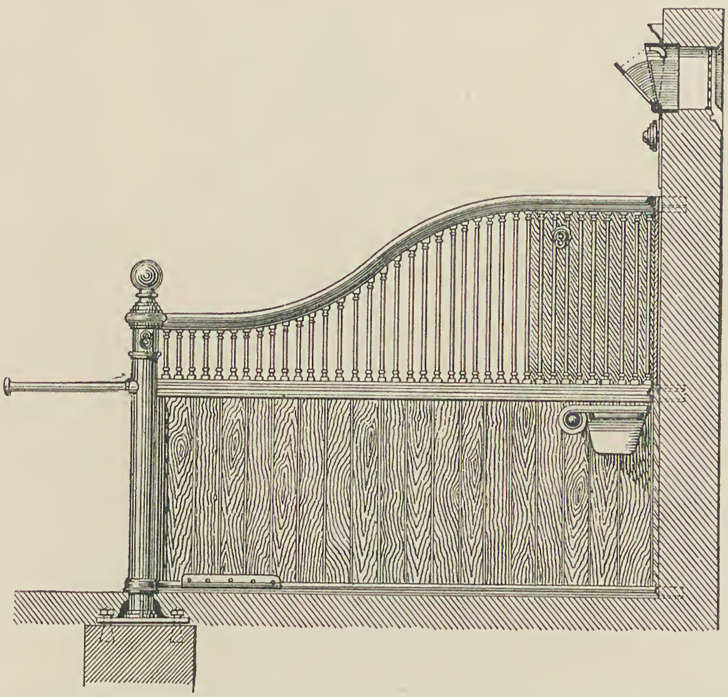

Fig. 726.—Stall-division with Shifting-piece in Sill, Sliding Bar in Middle Rail, and Ventilation over Horse's Head.

The lower parts of the walls of a stable are often lined with boarding, and the appearance is improved if this is secured into half-rails of iron at the top and bottom to match the divisions. In a high-class stable, a portion at least of the space above the boarding should be lined with glazed tiles, and the tiles should be continued to the same level above the mangers. The tiling is impervious to moisture, and being on that part of the wall upon which the horse breathes, or with which his body comes in contact, is easily kept clean and is not liable to decay. Salt-glazed bricks are now often used instead of wall-boarding, and are cleaner and more durable. The tiles above the wall-boarding or bricks should be of some light tint in preference to white. Dark tiles are not to be recommended. The upper part of the walls, if not tiled, may be plastered. Though more expensive, Keene's,

or some other hard-setting cement, is for hygienic reasons to be preferred, but ordinary plaster can now be cheaply coated with Duresco or several other preparations, which admit of being washed or renewed at a comparatively slight cost.

The stable floor should be impervious to moisture, capable of being easily cleaned, and with as few places for the lodgment of dirt as possible; the surface should have a sufficient foothold to prevent any risk of a horse slipping. The grooved vitrified clinker stable-paving bricks meet these requirements, and should be laid upon Portland-cement concrete. In the ordinary paving bricks the joints are at the bottom of the grooves, but it is better to have the grooves formed in the middle of the bricks, so that the joints are on the flats between the grooves. The floor should have as little slope as is consistent with the flow of liquids, so as to prevent the horses standing too much on an incline.

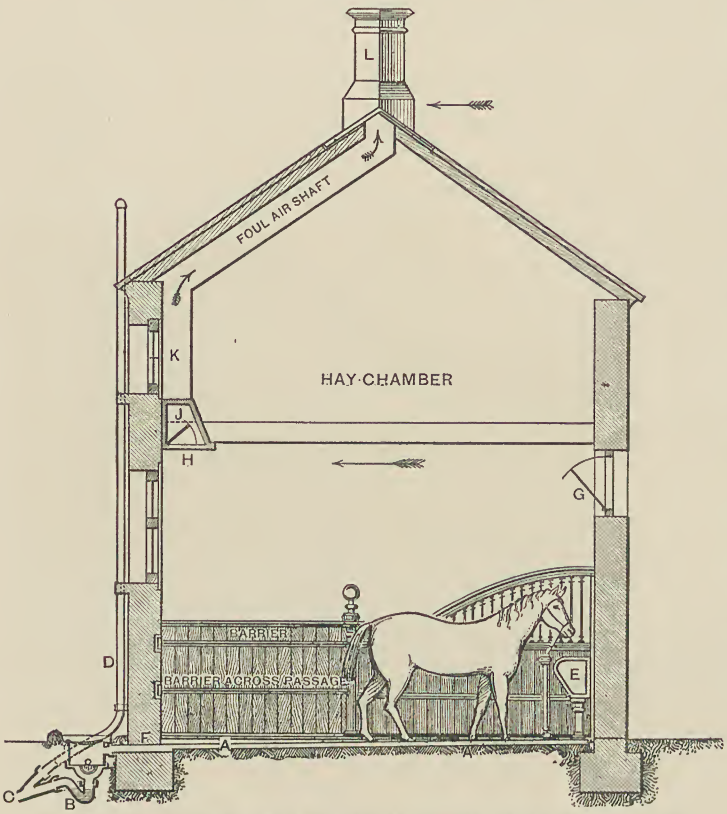

Fig. 727.—Section through Stable and Hay-loft, showing Drainage and Ventilation.

A, surface-drain or gutter; B, disconnecting-trap; C, glazed-pipe sewer; D, ventilation-pipe from sewer; E, patent waste-chamber of manger, with movable waste-pipe into the gutter; F, pipe through wall; G, air-inlet; H, air-outlet grate; J, valve for regulating outlet of air; K, foul-air shaft; L, extract-cowl.

Another excellent paving is formed with adamantine-clinker bricks. These are of a small size,—6 inches long, $2\frac{1}{2}$ inches deep, and $1\frac{3}{4}$ inches thick,—and are laid on edge in herring-bone fashion, upon concrete, with rather open joints, and grouted with cement. These clinkers wear with a gritty surface, and, being so small, the numerous joints afford a good foothold for horses. They are made with chamfered edges as well as square. Similar bricks are also made a little wider. Granolithic paving, composed of Portland cement and granite chippings, and laid on a foundation of brick or stone rubble, forms an excellent

floor when properly laid by experienced men, and has the great advantage of being in one mass without joints. It can be grooved in any desired way, one variety being shown in fig. 728, and channels can be formed in it to any width and slope. Ordinary cement paving is, however, quite unsuitable for stables, as it is soon damaged by the horses' shoes.

Channels should be laid down the centre of each stall and along the passage behind. The channel may be semicircular, of cast-iron, with a perforated flat top in sections made to slide, so that, by removing one of them, the attendant can slide the other pieces along and clean out the whole of the channel. By discharging the waste water from the drinking-pot into it, the flushing of the channel is rendered easy. Some persons prefer an entirely open gutter, as being less liable to choke up from neglect. The chief objection to open gutters is that they allow the liquids to be absorbed by the bedding, retaining them within the stable and vitiating the air. Musgrave's pattern (fig. 728) has a fall in itself, and is often used; the channels or corrugations provide for the flow of liquids to the drain, while the surface is almost level, and offers a good foothold for the horse.

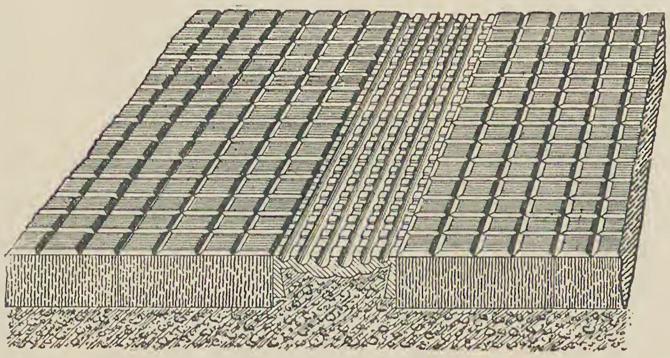

Fig. 728.—Musgrave's Open Surface-gutter.

The underground drains should be made of glazed stone-ware or cast-iron pipes, laid upon concrete, and jointed in the best modern manner. It used to be the idea that, on account of the great percentage of solid matter contained in the drainage from a stable compared with the liquid portion, a very large diameter of pipe was necessary. The theory of large pipes for house-drainage is now quite exploded, and there is no reason why it should be retained in the case of a stable. The contrary rather should be the case, for a small pipe running nearly full will be better flushed, and there will be a less deposit of sediment than with a larger one.

The same arrangements must be adopted for stable-drains as for house-drains. All inlets to the drains ought to be outside the building, as shown in figs. 724 and 727, and the inlets ought to be trapped. The trap shown in fig. 729 can be used for the purpose. The surface drainage from the stable ought to be carried through the wall by an iron pipe discharging over the

basket in the trap, and to prevent to some extent the risk of foul air being drawn through the pipe into the stable, a hinged brass flap may with advantage be fitted on the outer end of the pipe. It is desirable to have an inspection-manhole, with an air-tight cover, at every change of direction or important junction, so as to obviate as far as possible any necessity for lifting the drains and breaking up the yards and pavement. Another manhole must be constructed at a short distance from the point at which the drain is connected to the public sewer or to the private cesspool or underground tank, and in this manhole an intercepting trap must be placed to prevent foul air from the sewer or cesspool, &c., from entering the drains. To ventilate the drains an opening for air must be formed in this manhole, and at the head of the drains a drawn-lead or cast-iron ventilating-pipe, not less than $3\frac{1}{2}$ inches in diameter, must be carried up the building outside. These are shown in fig. 725.

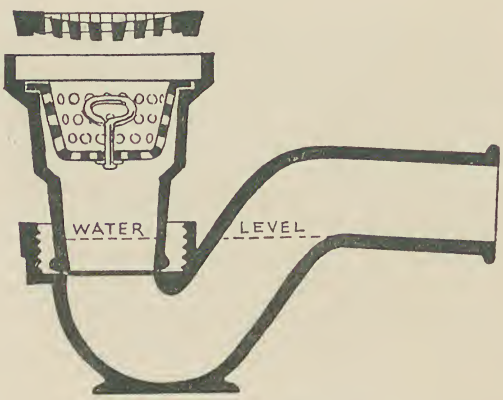

Fig. 729.—Winser's Stable Trap.

The chief features of **a stable trap** are that it should be very strong and that the attendant should be able to get his hand into every part; it should also provide as easy a flow for liquids as is compatible with a sufficient water-seal. Winser's stable trap, shown in fig. 729, fulfils these conditions, and contains a perforated metal basket which prevents straw and dung from entering the drains. This trap is made of either stone-ware or cast-iron, and as the body of the trap is in two pieces, the outlet can be turned in any direction.

Some Corporations do not allow any connection between stable-drains and the public sewers, and **an intercepting tank** may sometimes be required. This tank should not be too large; it should be impervious both at the sides and bottom; the top should be closed with an air-tight cast-iron cover, and due means should be taken for ventilation. Such a tank, however, must be viewed with more or less suspicion, and perhaps the safest way is to place it in a spot as little frequented as possible, with a ventilating grid made to lift easily, and to have it cleaned out at very short intervals.

The fitting up of **racks and mangers** has received great attention. The chief desiderata are—nothing that could injure a horse, or that a horse could injure, perfect cleanliness, and economy in the use of food by the horse. In many stables there are in every stall or loose-box three articles—a hay-rack,

manger, and water-pot, but the last is often omitted, as shown in fig. 730. All these are best made of iron, with enamelled lining to the manger and water-pot. The hay-rack answers best when on a level with the manger, the old-fashioned overhead rack allowing dust and particles of hay to fall into the horse's eyes, besides often allowing the food to be wasted. The low or trough rack, shown in fig. 730, is not open to these objections, as hay dropped by the horse generally falls again into the rack. This may be fitted with a sliding grid, which lies loosely on the top of the hay. The horse eats through the bars of this grid, which follows the hay as it diminishes, and prevents the waste by the horse pulling out too large mouthfuls at a time. A form of rack often recommended is quadrant-shaped, the bottom being on a level with the top of the manger, and in this case it should be fitted with a sloping perforated bottom, which allows the seed to drop through, and always keeps the hay close to the front of the rack, and within reach of the horse.

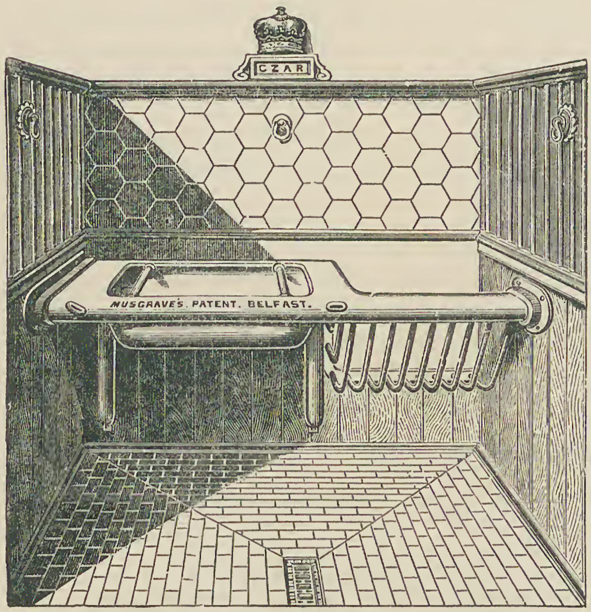

Fig. 730.—Manger, Hay-rack, &c.

The front of the manger should be of considerable strength, and rounded so that the horse cannot grasp it for "crib-biting". It is a great advantage to have the water-pot made without a brass plug or chain, but on the "tip-up" principle. This can be so arranged that while the attendant can turn it over to empty, the horse cannot possibly disturb it. The water is discharged into a waste-chamber, from which a metal pipe leads to a continuation of the stall-gutter; this is of great service for flushing the latter out. The tumbling principle may also be applied to the manger, rendering it more easily washed out when necessary. Another advantage in the manger is a cross-bar (fig. 730), which prevents the horse "nosing" corn or other food over the edge.

The tying of the horse in his stall is of some importance, and in this several improvements have been made, with the object of avoiding noise, and preventing the horse (if startled or frightened) injuring himself, or pulling away or breaking the manger. In the arrangement shown in fig. 731 the horse is not fastened to the manger, but the chain works through a long slit in the top plate,

or a front guide-ring, which allows it to play as freely as if there were no manger before the horse. The bracket supporting the manger holds back the halter-weight close to the wall. The weight has an india-rubber buffer on the top, which, when suddenly pulled up, strikes a flat place below the bracket and prevents noise, besides checking to some extent the shock to the horse. The upper end of the manger-chain or halter has a small ball, which stops when it comes to the slit in the top plate, and relieves the horse of the weight while feeding, the weight only coming into play when the horse draws back or throws up his head. There are several modifications of this principle, but all contain the buffer on the weight, and the ball to prevent it dragging needlessly upon the horse. Leather is sometimes substituted for the chain in the part passing through the ring, so as still further to reduce noise. The tying also is sometimes duplicated, so as to prevent all possibility of the horse breaking away.

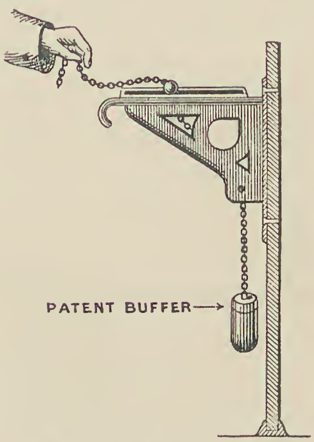

Fig. 731.—Musgrave's Horse-tying Arrangement.

The ventilation of the stable is of supreme importance, as probably one-half of the diseases from which horses suffer may be traced directly or indirectly to defective ventilation. The method found most satisfactory is by the introduction of a glazed ventilator (fig. 732) in the stable wall above the horse's head. The fresh air enters in an upward direction, and carries the air, as heated and contaminated by the horse's breath, towards the back of the stable. From this, one or more shafts, according to the size of the stable, but at least one to every three or four horses, should be carried up to discharge (if possible) at the ridge through a suitable ventilating-cowl. The system of ventilation is shown in fig. 727, page 468. Wherever practicable, windows ought to be provided in the front and back walls of a stable, and if another window can be placed in the gable end extending upwards to the ceiling, as in figs. 723 and 724, it will be a great improvement. These windows not only admit light, but if made to open can be adjusted to serve both as inlets and outlets for air.

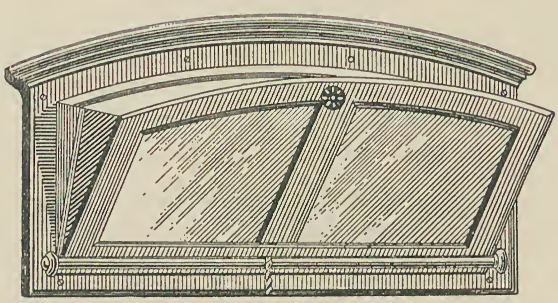
Fig. 732.—Combined Window and Air-inlet.

In ventilation, as in everything else about a stable, simplicity is of the first

importance. Beware of elaborate contrivances, that look pretty upon paper, but require constant attention to ensure their proper working. An automatic system depending solely upon the flow of the atmospheric currents, and the poise and counterpoise always going on between the inner and outer temperature and consequent weight of the air, may fail during some rare calm or on an exceptionally hot day, but, on the other hand, it is independent of the stableman, who probably understands but little of the theory of ventilation, and is liable to be careless or indifferent even when he does.

Another method of ventilation, first suggested by Mr. Alfred Waterhouse, R.A., is a modification of that generally known as "Tobin's". The end of the stall-division nearest the horse's head is cast hollow, in the form of an oblong tube, at the lower end of which the air is introduced by a grating in the outside wall, and passing up the hollow with an impetus towards the ceiling spreads out all round without draught.

As before stated, the heated air from the stable should not be allowed to escape into **the hay-loft,** either through traps in the ceiling or through other openings; a special air-shaft should be provided, and the hay brought down through a shoot if possible in an outside passage, or in the fodder-room. The loft-stairs also should not rise directly from the stable. To render the stable ceiling completely air-tight may not be easy, for plaster is not desirable under a hay-loft, and boarding, even when grooved and tongued, is apt to shrink and become far from impervious. Felt, or at least brown paper, laid under the floor-boarding or over the ceiling-boarding, answers the purpose well, however, and is not expensive. The hay-loft should, of course, be well ventilated by louvred windows, arranged to allow a full current of air through every part of the loft.

A good harness-room is an indispensable adjunct to every stable, and, where a number of hunters are kept, a saddle-room also is necessary. These should be placed as centrally as possible to the whole group of stalls and loose-boxes. One of these rooms is often a suitable place for the stairs giving access to a man's room above, and to the range of lofts. There should always be a fireplace, which is best fitted with a small range containing a large boiler to supply the hot water, which is so often required in stable-work. By continuing this boiler round both sides, as well as at the back of the fire, a very large supply will be always available. In small establishments the harness-room sometimes adjoins the coach-house, and a slow-combustion stove is placed in an open niche between the two. This may be sufficient to keep both places fairly warm and dry, but is of little use to give a supply of hot water or for cooking. A harness-room

may also with convenience contain a washing-sink, unless there is a separate cleaning-room, when it is better there. The tap over the sink will often be of service if the yard-cock is temporarily stopped by frost or other causes. The walls of harness-rooms should if possible be boarded, both for dryness, and for the facility of securing pins, hooks, &c.

The furniture of a harness-room is now of infinite variety. Formerly it was entirely of wood, and tended often to be somewhat clumsy, but a combination of

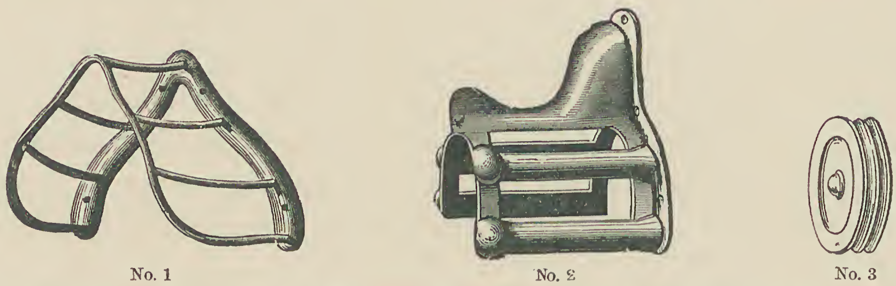

Fig. 733.—Harness Brackets. No. 1, Pad Bracket for Single Harness; No. 2, Collar-holder; No. 3, Whip-rack.

wood and iron has the advantage, alike in strength, lightness, and appearance. Harness being almost entirely of leather, and much exposed to damp, both from the weather and the horse's body, requires when hung up to have the parts separated from each other, and open to a free circulation of air, in order to ensure rapid drying and to prevent mildew. It is impossible within the limits

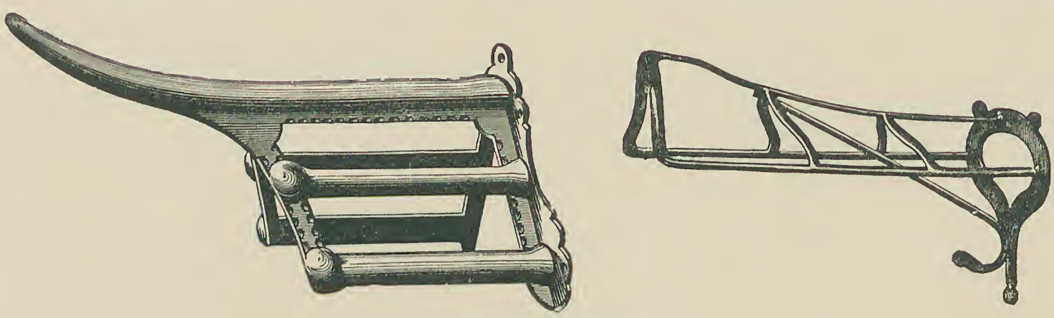

Fig. 734.—Saddle-brackets.

of our space to describe all the varieties of brackets for harness, saddles, collars, bridles, girths, whips, bits, reins, &c. Figs. 733 and 734 will give some idea of the principles which guide the manufacture and use of such articles. A contrivance for airing the inside of a saddle before the harness-room fire is shown in fig. 735. This when not in use will fold up, and can be hung against the wall. A saddle-and-harness-cleaning horse, which combines a press and drawers for horse-clothing and cleaning articles, with provision for opening out the saddle-horse to form a table, may be found very useful where space is confined.

There are also many other conveniences, if not requisites, for the harness-room, such as brush and sponge drainers, chamois-leather and brush boxes, wall-brackets to hold carriage-lamps when not in use, &c.

In large establishments it may be found convenient to have **a spare harness-room** for the reception of articles not in daily use, as in the case of town or country houses occupied by the family in turn for a part only of the year. This will apply especially to country houses in which there may be a large influx of guests during the hunting season. Particular care should be taken of the warming of such a room, as leather and steel goods, when laid away, are very susceptible to damp. In regard to this, it may be borne in mind that stagnant air, even when warm, is more conducive to mildew than much colder air when freely circulated, and therefore that attention to ventilation is of great importance, both in a harness-room and coach-house.

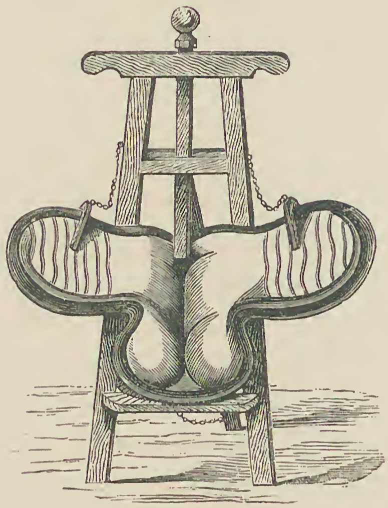

Fig. 735.—Saddle-airer.

The fodder or provender room is indispensable where a large number of horses are kept. It should be fitted with bins overhead for corn, &c., and a chaff-cutter. It is desirable that the corn-shoot and hay-shoot should discharge into this room instead of into the stable. These shoots are now made to measure the exact quantity of an ordinary feed for a horse. In large stables there may also well be an extra house for the storage of roots.

The coach-house need not be closely adjoining the harness-room, though in small establishments it may be convenient to place it so. In depth it should be about the same as the stables, *i.e.* eighteen feet in the clear. The length will depend upon the number and class of vehicles to be accommodated. Although few carriages even with lamps exceed seven feet in width, the doors should never be less than eight feet wide, and are better made nine feet or over. There is a great convenience in making the doors to slide, as when hung with hinges they are liable to be blown about by the wind. This can be accomplished by a little manipulation of the piers, and the sliding doors are generally hung with sheaves at the top to run along an iron bar. There should be small rollers at the bottom to reduce the friction. The floor may be laid with smooth flags, either natural or artificial, or concrete, but in this case especial care should be taken of the quality of the cement and sand used, as concrete may be very good or very bad

according to the materials of which it is made. Asphalt is sometimes used, but is liable to become soft in extremely hot weather. Tiles are not desirable, from the risk of breakage. A coach-house should always have the means of being warmed. As before stated, in small places it sometimes adjoins the harness-room, and a slow-combustion stove is placed in a recess in the division wall between, but in larger places a separate means of heating by hot-water pipes will be necessary, and, as in the case of the harness-room, some provision should be made for ventilation.

The apartment for the hot-water boiler may be utilized as a coal-house, and for the barrows, forks, shovels, buckets, and other tools, which form the necessary outfit of a stable-yard. Slow-combustion stoves are now made with a boiler sufficient to supply hot-water pipes for the coach-house and harness-room. It may sometimes be possible to combine an auxiliary-pipe for the coach-house with a set for the greenhouse, but it is not desirable to sacrifice convenience in other respects for this purpose.

Much advantage will be found from having at least a portion of **the yard** covered in, and some very comfortable yards are entirely so; but in these sufficient provision should be made for allowing a free circulation of air at the sides, care being taken, should the situation be exposed, that in high winds the air has a sufficient escape in several directions, so as to avoid any risk of the roof being lifted.

Convenient but not too close to the coach-house doors, there should be a proper **carriage-washing stand,** arranged with a sufficient fall to a gully, Newton's medium size being very suitable. The washing-place should be not too far from the horse-washing stand or shed, so that the hose and attachment for washing the horses can also be within reach for the carriages. Of course if the number of horses is large, it may be desirable to have a separate water-supply and hose for the carriages. Besides the hose attachment, there should be a tap at the proper height for filling buckets for the stable use, even if, as in the best stables, the water is laid on direct to each stall.

In arranging for **the water-supply** to a stable, much will depend upon the site. Town and suburban stables will generally avail themselves of the local supply, for which much storage will scarcely be needed, and the pressure will be sufficient for the hose and other purposes. In the country, however, a special supply will generally have to be provided. Rain-water is often valued for this purpose, and if it is collected from the stable roofs, the cistern will have to be fixed at a suitable level below the eaves; the higher its position, the greater head of pressure there will be for the discharge from the hose. The tanks, when not too large,

may be of galvanized iron, but slate forms a very clean and durable material, and for very large tanks boiler-plate iron is a strong and cheap material. Where the rain-water is used for drinking, it is better for being filtered. A very efficient filter for stable purposes may be formed by dividing the tank into two sections by a diaphragm reaching to within a few inches of the bottom, and placing a false bottom of perforated wood or a galvanized-iron grating, about six inches above the real bottom. This grating should have a layer of not less than twelve inches of crushed coke. The water would enter the tank on one side, pass through the layer of coke and under the diaphragm, and ascend through the layer of coke on the other side. A better arrangement would be to have the filter above the cistern, as it would not then be always water-logged, and would have full opportunities for aëration. Two filters might be provided, one being in use and the other being laid aside for aëration or repairs.

The gates for the yard should be at the least ten feet in width, and may be arranged to slide. A side-door should also be provided.

The manure should, if possible, be stored at a distance from the stable-yard, and removed by a small covered cart or barrow as collected daily or more often from the stalls. The manure-pit should always have a solid concrete bottom and be roofed over, and every precaution should be taken to prevent liquids penetrating the soil, for they often travel underground for a great distance, and may pollute wells supposed to be quite beyond their influence.

The London by-laws relating to the construction and maintenance of receptacles for dung may be thus summarized:—

1. The capacity must not be greater than 2 cubic yards.
2. The bottom must not be lower than the surface of the adjacent ground.
3. The contents must not be allowed to escape, and there must not be any soakage from the receptacle into the ground or into the wall of any building.
4. Rain and surface water must be excluded in such a manner that the receptacle is freely ventilated into the external air.
5. If the contents are removed at least once in every forty-eight hours, the capacity may be greater than 2 cubic yards, and a metal cage may be used, the ground under the cage to be properly paved to prevent soakage into the ground, and any wall, "near to or against" which the cage is placed, to be adequately cemented to prevent soakage into the wall.

It will also be necessary to provide suitable **latrines** for the stable attendants. Water-closets should be used if the supply of water is abundant, but earth-closets of a good type and properly attended to are also satisfactory.

The accommodation required for cart-horses is of course of a much simpler

nature than for the carriage or riding horse. Not only is the horse generally of a heavier make, and of a less sensitive constitution, but he is looked upon as an unit of business who is expected to "pay his way", and who must therefore dispense with luxury. Still more is this the case in the stables of omnibus or tramway companies, or other large commercial undertakings. Everything in these has to be contrived to combine efficiency with economy, for which indeed the former is or ought to be only another name. The space is reduced to a minimum, five feet being generally considered enough for the width of each stall, though for large cart or dray horses more ought to be allowed. Space is also often economized in the width by placing the horses back to back with a passage in the middle. Thus with stalls nine feet long and a passage seven feet wide between, and a door at the end, a stable twenty-five feet wide will accommodate two rows of horses. It will hardly be advisable, however, unless with doors at both ends, to have more than about eight or ten stalls on each side.

The fittings must all be of the strongest and simplest kind. Metal capping will still be the best to prevent "crib bitting", but the remainder of the divisions may be of pitch-pine or spruce, both being hard and tough. "Swinging bars" have been sometimes tried to give at least the pretence of greater space in the stalls, but they are not satisfactory, and with any but the quietest horses may give rise to more trouble than comfort. In places where they have been introduced, they have been soon abandoned. The mangers and pots are often of glazed fire-clay, as being probably more durable than enamelled metal, and can be made with a fire-clay bar across to prevent nosing out the food. Hay-racks are often dispensed with, as chopped fodder is the custom in all these stables.

In the long run square sets, though dear at first, will generally be found to make **the most economical floor,** and, with the general introduction of peat-litter, drainage is dispensed with. With an impervious bottom, and care in the management of the litter, and of course ample ventilation, it is surprising how sweet a crowded stable can be kept even in summer.

With practically no more harness than a trace and collar, in the case of **tramway or 'bus stables,** each horse's harness can be hung upon his own stall-post. A special harness-room, except as a store, is hardly required, but in these large stables, where the horses are counted by the hundred, a harness-repairing shop, and a forge or shoeing shop, will each form a most important branch. A number of loose-boxes for horses sick or temporarily disabled, or on trial, will be very necessary. One for every eight or ten horses kept will not be too many. In stables of this size an engine and boilers to supply the power for cutting up the fodder and bruising and mixing the corn, and in some cases for pumping

water, are indispensable, and will keep a special staff of assistants in full work, cutting, weighing, and filling into bags. In the passages between the various ranges of stables, strong rings should be built into the wall to secure the horses while being groomed, though a regular washing and grooming shed may be more convenient, and offer greater facilities for inspection. All provisions for cleanliness are of even greater importance than in the gentleman's stable. The manure-pit must not be large, and must have both sides and bottom impervious to moisture, and the removal should be daily. In the stables of one of the best-managed tramway companies, the principal walls, &c., are whitewashed monthly, and at the horses' heads every week. Lime-wash is a great and cheap purifier.

In many large city stables, still further to economize space, the **horses are accommodated on two stories,** the upper part being reached by an inclined plane or gangway. This gangway has to be made with cross pieces of wood, well covered with gravel or litter to prevent slipping. The floor of the upper stalls is best made of steel joists and concrete, which, with the great modern facilities for the production of these articles, involve very little extra trouble or expense. Naturally a little more care will have to be taken with the ventilation and lighting of the lower story, and, indeed, where possible, it is better to utilize this for subsidiary purposes, such as forges, harness-repairing, &c.

CHAPTER II.

COW-HOUSES.

The horse is with justice considered to be the nobler animal, and the useful cow must always take the second place, and until lately almost any accommodation has been considered good enough for her. The housing of the one or two cows that supply milk to the suburban gentleman's family, is a matter of such simplicity that little need be said about it, but the construction of the large city dairies, or of the byres upon the great milk-raising farms which surround our large towns, is now recognized to be a matter of **the most vital importance.** In its relation, indeed, to the health of the community, it is of infinitely greater moment than the construction of any stable can be. This has been to some extent recognized by the law, but there are many features that the law cannot, or does not, touch. In the construction of cow-houses even more than in stables, two opposing principles are contending for the first place. From the point of

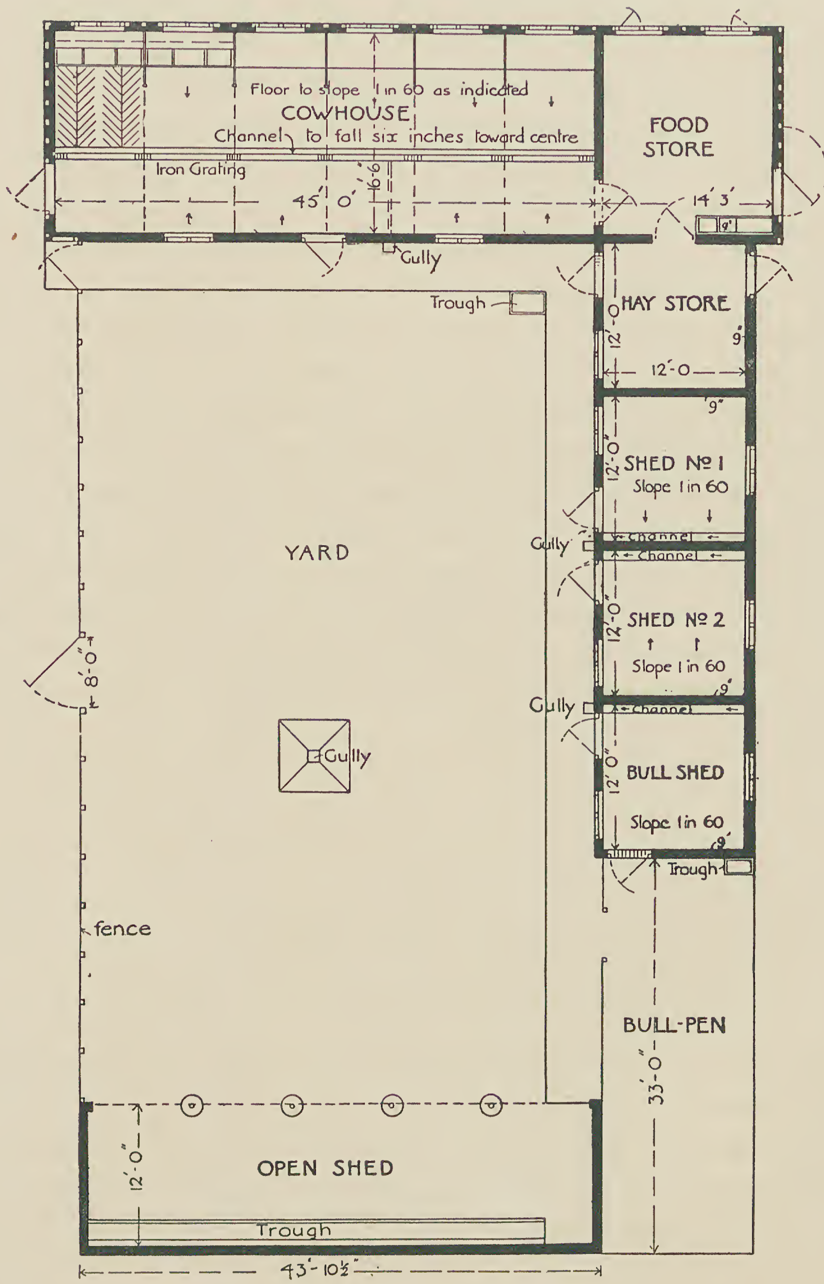

Fig. 736.—Plan of Cow-houses

view of the producer economy comes first, from that of the consumer health, and the opposing needs of these two have to be reconciled.

In large and economically-worked houses, there are **two systems of arrangement,** each having its advantages. The one is with the cows in two rows with

their heads facing a feeding-passage in the centre, and of course having a passage of access behind each row of cows adjoining the outer walls. The other system is to have a double row of cows with their tails opposite each other and a single passage of access in the centre, and with the heads of each row of cows pointing to a narrow feeding-passage along each outside wall. This arrangement is adopted at some of the Government model farms. The whole building is 32 feet wide; the feeding-passage along each wall is 4 feet wide, and has a sunk portion along which a feeding-truck can run. Down the centre runs a passage 5 feet in width, which allows a standing depth of 9 feet 6 inches for each cow. A separate house for one or more sick cows is useful in all large ranges of buildings. Fig. 736 shows a small range of buildings designed by the editor for the home farm in connection with a country house.

The fittings usually consist of cast-iron stall-divisions arranged for two cows in each stall, with a cast-iron or stoneware feeding-trough, and a wrought-iron hay-rack above. The distance between the divisions to accommodate two cows is usually 7 feet, and occasionally 7 feet 6 inches or 8 feet. Sunk flush in each division should be an upright tying-rod, arranged to be easily removable in case of accident. As in the case of stable-fittings, everything should be smooth and rounded, and so made as to avoid any possibility of the cow hurting herself. The feeding-trough should be capable of being filled and flushed with water, which when discharged will in its turn serve to flush out the drain or channel. A water-trough or pot may be provided at a suitable height above the feeding-trough, in the centre of each bay, and can be automatically supplied from the main tank.

The floor of the passage and of the lower part of the stalls is best formed of concrete with a floating of hard cement on the top, but some authorities prefer that the part under the cows' fore-feet should be of earth only, covered with litter. Probably, however, concrete for all will be the cleaner, an ample supply of litter making a soft enough provision for standing or lying.

For covering the walls nothing is so good as **whitewash,** which can hardly be too often renewed.

The Model Regulations issued by the Local Government Board specify that the walls and ceilings of every cow-shed shall be "properly lime-washed *twice* at least in every year, that is to say, *once* during the month of May and *once* during the month of October, and at such other times as may be necessary", except those parts "that may be properly painted or varnished or constructed of or covered with any material such as to render the lime-washing unsuitable or inexpedient, and that may be otherwise properly cleansed".

Drainage.—The same regulations require the drainage of every cow-shed "to be so arranged that all liquid matter which may fall or be cast upon the floor may be conveyed by a suitable open channel to a drain inlet, situate in the open air, at a proper distance from any door or window of such cow-shed, or to some other suitable place of disposal which is so situate". To emphasize the importance of disconnecting the drains, a further regulation provides that there shall not be "any inlet to any drain of such cow-shed . . . within such cow-shed". In other words, the drains must be arranged in the manner recommended for stables in Chapter I, and shown in figs. 724 and 727.

The most ample ventilation is indispensable. A simple air-inlet grating opposite each cow's head, or a window of the kind shown in fig. 734, answers well, with an outlet-ventilator on the roof, (say) one to every ten cows. One of the many varieties of outlet-ventilator is shown in fig. 737.

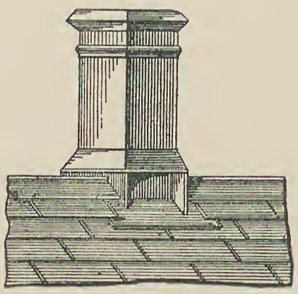

Fig. 737.—Musgrave's Outlet-ventilator.

Unless the cows "are habitually grazed on grass land during the greater part of the year, and, when not so grazed, are habitually turned out during a portion of each day", a cow-shed must not be "occupied by a larger number of cows than will leave not less than eight hundred feet of air space for each cow". In calculating the air space, "no space shall be reckoned which is more than sixteen feet above the floor". Every cow-shed must also be "sufficiently lighted with windows, whether in the sides or roof thereof".

Dairy-arrangements for the storage and distribution of milk hardly come within the scope of this work, but among the **general requirements** which must be mentioned are hay-lofts, root-stores, and a preparation-room for provender with boiler, &c., and, of course, accommodation for the men, latrines, manure-pits, proper water supply, &c., but in these there is nothing specially distinctive from those required for commercial stables. In everything that pertains to the accommodation of cows it can only be iterated again and again, that, in the future, considerations of cleanliness and health will become more and more paramount, and that the regulating sanitary laws and their enforcement will become increasingly stringent, though quite possibly this may take the form rather of greater intelligence and frequency in the supervision, than of much greater stringency in the laws themselves.

SECTION XX.—SANITARY LAW

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SECTION XX.—SANITARY LAW.

CHAPTER I.

ENGLAND AND WALES (*EXCEPT LONDON*).

1. *SANITARY DISTRICTS AND AUTHORITIES.*

(1.) **Sanitary Districts and Authorities.** For the purposes of Public Health administration, England and Wales are divided into districts, as follows:—

(*a*) *Counties*, governed by County Councils.

(*b*) *Urban Sanitary Districts*, governed by Urban District Councils.

(*c*) *Rural Sanitary Districts*, governed by Rural District Councils.

(*d*) Besides these larger divisions, the *Rural Parishes* are for certain purposes governed by Parish Councils or Parish Meetings. Parishes with a smaller population than 300 may be grouped together, so that here and there groups of small parishes have their common Parish Council (Local Government Act, 1894, §§ 1–3).

The Local Government Board exercises a superintending authority over the whole.

(2.) **London.** The County of London has, to a great extent, a separate sanitary administration, and will be considered separately.

(3.) **The Sanitary Powers of County Councils.** The County Councils have a certain amount of supervisory power over the administrative smaller areas of the county; if, on investigation, they find that a local District Council is not performing properly its statutory duty, they may make a complaint to the Local Government Board (Public Health Act, 1875, § 299). The County Councils may enforce the Rivers Pollution Prevention Act; they may appoint a Medical Officer of Health; and they have the same power of making by-laws in relation to nuisances within their counties, or any specified part of them, as boroughs under the Municipal Corporations Act (45 and 46 Vict., cap. 50); the by-laws,

however, have to be confirmed by the Local Government Board. Such by-laws apply to all parts of a county except boroughs.

(4.) **The Sanitary Powers and Duties of Urban and Rural District Councils, and of Parish Councils.** These powers, speaking generally, are the abatement of nuisances; the making and maintenance of sewers and the disposal of sewage; the healthy construction of houses; the supervision or enforcement of the provision of water-supplies; the enforcement of provisions relating to infectious diseases; the making and enforcement of by-laws, and the carrying out of various Acts of Parliament relating to occupations, and to food and to sanitation generally. Parish Councils, although possessing but a limited power of dealing with certain specified nuisances (Local Government Act 1894, § 8), can do great good to the community by drawing the attention of the District Councils to nuisances, insanitary dwellings, inadequate and polluted water-supplies, and other evils.

2. *NUISANCES.*

(5.) **Distinction between "Nuisance" at Common Law and "Nuisance" under the Sanitary Acts.** The term "nuisance" is a wide one. Nuisances in a legal sense may be divided into: 1. Nuisances at Common Law; and 2. Nuisances under the Public Health and Sanitary Acts.

Nuisance at Common Law does not come within the scope of this treatise. All that need be said is that Common Law nuisances are usually divided into *Public* (or Common) and *Private* Nuisances.

Public Nuisances are abated by indictment. They are supposed (at all events technically) to be matters which cause inconvenience or damage to the public in the exercise of their common rights; such, for example, as the obstruction of a highway, interference with the navigation of a stream, the storage of explosive substances in places likely to be dangerous, noise, indecent exposure, and several matters affecting the public morals. Some classes of nuisance which may be proceeded against by indictment, might also be dealt with under the Public Health Act, 1875; such, for example, as pollution of the air, and smoke from a factory.

Private Nuisances are defined as acts interfering with the proprietary rights of another in land, but which do not amount to a trespass. Special annoyance from noise or from smoke have been considered to belong to this category. The remedy is an action for damages, or for an injunction, or for both.

(6.) **Nuisance under the Public Health and Sanitary Acts.** Nuisances under the above Acts will be usually embraced in the following definition:—

A nuisance is something which is either expressly declared to be so by statute, or, where not mentioned expressly, it is something which either actually injures or is likely to injure health, and admits of a remedy, either by the individual whose act or omission causes the nuisance, or by the Local Authority.

Throughout England and Wales (save London) the chief section of the Public Health Act, 1875, operative against nuisances, is Section 91. This section states that premises, pools, ditches, gutters, water-courses, privies, urinals, cesspools, drains, ash-pits, animals, accumulations, and deposits, may all be nuisances or injurious to health; the section also declares that overcrowding in houses, rooms, vans, tents, sheds, or similar structures used for human habitation, to a degree "dangerous or injurious to the inmates", is to be considered a nuisance. Factories (not under the operation of the Factory Acts), workshops, and workplaces, not kept in a cleanly state or ventilated in such a manner as to render harmless the gases, vapours, or dust generated therein, come under the same category; overcrowding while work is carried on, if dangerous or injurious to health, is also considered a nuisance. Fireplaces or furnaces used for working engines by steam, or in any mill, factory, bakehouse, dye-house, brewery, or gaswork, not consuming, "as far as practicable", their smoke, and chimneys (other than those of private dwellings) sending out "black smoke" in quantity, are all nuisances within the meaning of the section.

The word nuisance is also connected by the Public Health Act, 1875, with the destruction, cleansing, or discontinuing of sewers (§ 18); the cleansing, covering, or ventilation of sewers (§ 19); the disposal of sewage (§ 27); the construction of drains, water-closets, earth-closets, privies, ash-pits, and cesspools (§§ 40, 41); with snow, filth, dust, ashes, and rubbish (§ 44); with swine, pigsties, waste and stagnant water in cellars and dwellings; with the overflow of the contents of water-closets, privies, and cesspools (§ 47); and with certain offensive trades (§§ 112, 113, 114).

Abandoned shafts of quarries and mines within fifty yards of a path or road in unenclosed land are also to be considered nuisances under the Public Health Act, 1875, the Quarry Fencing Act, 1887 (50 and 51 Vict., cap. 19), the Coal Mines Regulation Act, 1887 (50 and 51 Vict., cap. 68), and the Metalliferous Mines Act, 1872 (35 and 36 Vict., cap. 77).

The law as to nuisance not only applies to houses, but also to all ships and vessels under the British flag (other than his Majesty's ships) lying in any river, harbour, or other water within the district of a Local Authority (Public Health Act, 1875, § 110).

(7.) **Information as to Nuisances.** Information respecting nuisances may be

given to the Local Authority by any person aggrieved by the nuisances, or by any two inhabitant householders, or by any officer of the Local Authority, or by the relieving officer, or by any constable or police officer of the district (Public Health Act, 1875, § 93).

(8.) **Abatement of Nuisance.** On receipt of such information, and if satisfied that the nuisance exists, the Authority is bound to serve a notice on either the owner or occupier, or the person causing or suffering the nuisance, the owner being served in cases of some structural defects. If there is no fault with regard to owner or occupier, and the person causing the nuisance cannot be found, then the Local Authority may abate the nuisance (*ibid.*, § 94). Should the notice of the Local Authority not be obeyed, a summons is applied for. When this is granted, the case is heard before a Court of Summary Jurisdiction, which court, if satisfied of the existence of a nuisance, is compelled to make an order to abate it, or both to abate it and prevent its recurrence. A penalty may also be imposed and costs. One of the most important powers possessed by the Court of Summary Jurisdiction is the power of closing premises as unfit for habitation, until the premises are rendered fit for that purpose (*ibid.*, §§ 95, 96, 97, 98). In certain cases there is a power of appeal to the Local Government Board by a person aggrieved by a notice from a Local Authority (*ibid.*, § 268). A person aggrieved by an order or conviction of a Court of Summary Jurisdiction has also the power of appeal under certain conditions to Quarter Sessions (*ibid.*, § 269).

3. *SEWERAGE AND DRAINAGE.*

(9.) **Distinction between "Drain" and "Sewer".** The word "drain"[1] is defined by the Public Health Act, 1875, to mean any drain used for the drainage of one building only, or of premises within the same curtilage, for the purpose of draining into a cesspool or other receptacle, or into a sewer. Hence, as a rule, if a drain of one building join another, from the junction of the two drains the conduit is technically a "sewer". Indeed, in the case of Travis *v.* Uttley (70 T. L. R. 242) the court seemed to extend the definition to even the portion of the drain before the junction. In districts where the authorities have adopted the Public Health Acts Amendment Act, Section 19, this definition does not precisely hold good; in such places, if two houses belong to different owners, the combined drain is a "drain" reparable at the owners' expense; if, on the contrary, the same person owns the two houses, the combined drain is a "sewer".

[1] Pipes carrying off surface or rain water only come within the definition of drain; Holland *v.* Lazarus, 1897, 66 L. J., Q. B. 285.

"Sewers" include drains and sewers of every description, except drains to which the word "drain" interpreted as aforesaid applies, and except drains vested in and under the control of any authority having the management of roads, not being a Local Authority under the Public Health Act, 1875.

(10.) **Duties and Powers of Local Authorities as to Sewers.** With a few exceptions (see Public Health Act, 1875, § 13), all sewers vest in the Local Authority and are under its control, and the Authority is responsible for their repair and maintenance. The Local Authority is bound to provide its district with sewers where necessary (Public Health Act, § 15). It may also purchase existing sewers or accept the gift of such sewers (*ibid.*, § 14). Local Authorities have extensive powers with regard to laying sewers, and to entry on premises for the purpose of examining and repairing sewers, and ascertaining their course, and also with regard to preliminary examination of the course of a proposed sewer. They cannot, however, enter private lands for the purposes of making new sewers without permission, or without compensation, if such compensation is demanded.

The definite duties laid upon Local Authorities with regard to sewers appear to be at least four:—

1. To provide necessary sewers (Public Health Act, 1875, § 15).
2. To keep all sewers belonging to them in repair (*ibid.*, § 15).
3. To construct, repair, cover, and ventilate their sewers in such a manner that they shall not be a nuisance or injurious to health (*ibid.*, § 19).
4. To properly cleanse and empty their sewers (*ibid.*).

(11.) **Right to the Use of Sewers.** The owner or occupier of property in any district has a right of drainage into the sewers of that district (Public Health Act, 1875, § 21). If the sewer is in one district and the property in another, the house may be drained into the sewer by agreement with the Authority in whose district the sewer is situate.

(12.) **Protection of Sewers.** In Urban Districts it is unlawful to build over a sewer without the express permission of the Authority.

Districts may adopt Part III. of the Public Health Acts Amendment Act, 1890, Section 16, which makes it an offence for any person to throw or suffer to be thrown into any sewer, or into any drain communicating therewith, any matter or substance by which the free flow of the sewage or storm-water may be interfered with, or by which the drain or sewer may be injured. Section 17 further makes it an offence to permit to enter directly or indirectly into a sewer, chemical refuse, waste steam, condensing water, heated water, or other liquid of a higher temperature than 110° F., which, either alone or in combination with

the sewage, causes a nuisance or is dangerous or injurious to health, under a maximum penalty of £10, and a maximum daily penalty of £5.

(13.) **House-drainage.** Every house in town and country must have a drain of sufficient capacity, discharging into any public sewer which extends within 100 feet of the house. If no such sewer exists, the drain must discharge into a cesspool, or into any other place, "not being under any house", as the Local Authority may direct. Drains are to be made of such materials and sizes, and to be laid at such levels and gradients, as the surveyor of the Local Authority may advise. If a house is without effectual drainage, it is the duty of the Authority to request the owner, by formal notice, to construct a suitable drain; in default of compliance, the Local Authority may do the work, and recover in a summary manner the expenses, or may by order declare them to be "private improvement expenses".

Should it be less expensive for the Local Authority to construct a new sewer to receive the sewage of two or more houses than to compel the owners to drain them into existing sewers, they have power to do so, and to apportion the expense of the construction among the owners of the several houses, or they may, by order, declare the expenses to be "private improvement expenses" (Public Health Act, 1875, § 23).

(14.) **Power to examine existing Drains.** On the "written" application of any person to a Local Authority, stating that any drain or other thing is a nuisance or injurious to health, the Local Authority has power after twenty-four hours' notice to the occupier—or, in case of emergency, without notice—to enter the premises, open up the ground, and examine the drain. If no fault is found, all damage must be made good at the Authority's expense; if, on the contrary, the drain is found in bad condition or to require amendment, notice must be given to the occupier, calling on him to undertake the necessary repairs or renewals. Neglect to obey such notice involves a penalty of 10 shillings per day or less, and the Local Authority may forthwith do the work, and recover summarily the expenses, or declare them to be "private improvement expenses" (Public Health Act, 1875, § 41).

(15.) **The Drains of New Houses.** In an Urban District it is illegal to erect a house, or to rebuild one which has been pulled down to or below the ground-floor, without proper drainage, under a penalty of £50 or less. It is also unlawful to occupy a house if so constructed. (Public Health Act, 1875, § 25.)

4. *WATER AND WATER-SUPPLY.*

(16.) **Powers and Duties of Local Authorities as to Water-supply.** All public cisterns, pumps, wells, reservoirs, aqueducts, and works used for the gratuitous supply of water, vest in the Local Authority, and the Authority *may* cause the same to be maintained, "and plentifully supplied with pure and wholesome water".

In the absence of a Water Company, or with an existing Water Company's consent, the Authority has power to construct works for the *gratuitous* supply of water (Public Health Act, 1875, § 64).

Similarly, in the absence of a Water Company, or in cases in which the Water Company cannot and is not willing to allow a sufficient supply of water to a district, the Local Authority has full power to supply the district with water, and to execute any necessary works, or to purchase, with the sanction of the Local Government Board, any existing water-works or rights (Public Health Act, 1875, §§ 51, 52). The section reads as if it were permissive, but if wholesome water is needed, the word "may" really means "shall", a default in supplying water under these circumstances being an offence under the Public Health Act, 1875, § 299.

Local Authorities have powers to carry water-mains within or without their district similar to those exercised in the case of sewers (Public Health Act, 1875, § 54); the Water-works Clauses Act, 1863, and certain provisions of the Water-works Clauses Act, 1847, are incorporated with the Public Health Act, 1875.

Parish Councils also have urban powers with respect to the utilization of any well, spring, or stream within the parish; the expenditure of maintenance is limited to 3*d.* in the pound on the rateable value of the parish, save with the consent of the Parish Meeting (Local Government Act, 1894, §§ 8, 11).

(17.) **The Supply of Water to Dwelling-houses.** Urban Authorities, unless by Order of the Local Government Board they have been invested with powers conferred under the Public Health (Water) Act, 1878, have somewhat less power than Rural Districts to enforce a water-supply to dwelling-houses. The general powers applicable to both Urban and Rural Authorities under § 62, Public Health Act, 1875, are briefly as follows:—If it appears that a house is without a proper water-supply, according to the report of their surveyor, and such a supply can be furnished thereto, at a cost not exceeding the water-rate authorized by any local Act, or (where there is no local Act) at a cost not exceeding twopence per week, or at such other cost as the Local Government Board may determine

on the application of the Local Authority, then the Local Authority must give notice to the owner, requiring him to supply the house with water. In case of non-compliance the Local Authority may do the work, and recover in the usual way the expenses, or they may enter into a contract with a Water Company for supplying the house, and the premises may be compulsorily rated. Although this power is generally applicable to Rural and Urban Districts, its operation is mainly confined to Urban Districts, because the words, "furnished thereto", taken in conjunction with the context of the section, evidently refer to a supply from water-mains, and are considered not to apply to wells.

(18.) **Special Powers of Rural Sanitary Authorities.** The Public Health (Water) Act, 1878, is in force in all Rural Districts. It is also applicable to Urban Districts by order of the Local Government Board. Under section 3 of this Act it is the duty of the Sanitary Authority of a district in which the Act is in force, to "see that every occupied house within their district has, within a reasonable distance, an available supply of wholesome water, sufficient for the consumption and use for domestic purposes of the inmates of the house". When it appears to a Local Authority, on the report of their sanitary officers, that an occupied dwelling-house has not such a supply, and such supply can be provided with the outlay of capital which, at 5 per cent interest, would not exceed 2*d.* per week (that is, a sum of £8, 13*s.* 4*d.*), or at a greater cost sanctioned by the Local Government Board (not, however, exceeding £13), then by a somewhat complicated procedure the supply may be enforced. The procedure, indeed, gives so many facilities for an obstinate owner to delay the supply, that if every technical objection is taken, many months must necessarily elapse before such supply is given.

New houses cannot be occupied in districts in which the Public Health (Water) Act, 1878, is in force, unless the Sanitary Authority has certified that there is an available source of supply within a reasonable distance. A person may appeal to a Court of Summary Jurisdiction should a Local Authority refuse to give such certificate, and the Court may, on hearing the case, make an order authorizing the occupation of the house.

(19.) **Pollution of Water.** There are various powers with respect to the pollution of water by gas or gas-products both under the Public Health Act, 1875, and the incorporated Water-works Clauses Acts; the chief working section is, however, Section 70, Public Health Act, 1875. This provides that, on the representation of any person to a Local Authority that within their district the water in any "well, tank, or cistern, public or private, or supplied from any public pump, and used or likely to be used by man for drinking or domestic

purposes, or for manufacturing drinks for the use of man, is so polluted as to be injurious to health", the Local Authority may take action before a Court of Summary Jurisdiction to remedy the same. Unfortunately, many of the benches of magistrates consider the words "injurious to health" not synonymous with "dangerous", and require proof of actual injury, a proof rarely possible.

(20.) **Prevention of the Pollution of Streams, Water-courses, and Rivers.** Under the Public Health Act, 1875, a Local Authority, with the sanction of the Attorney-general, may take proceedings by indictment in Chancery "for the purpose of protecting any water-course within their jurisdiction from pollutions arising either within or without their district" (§ 69). The chief legal powers relative to the pollution of streams are, however, contained in the Rivers Pollution Prevention Act, 1876 (as amended by the Rivers Pollution Prevention Amendment Act, 1893). This act may be enforced by either the Local Authorities, the County Councils, or both. Under this act three kinds of pollution are dealt with:—(1) solid matters; (2) sewage; and (3) manufacturing and mining pollutions. But little action has, until quite recently, been taken under the Act with regard to solid matters, or to mining and manufacturing refuse.

The powers with regard to sewage-pollution are those that are the most useful and applicable. It is an offence for any person knowingly to allow sewage-matter, directly or indirectly, to get into a stream. In the amended Act, it is specially laid down that, when sewage is carried along channels vested in a Local Authority, and such sewage falls or flows into a stream, the Sanitary Authority shall, for the purposes of the Act, be deemed to "knowingly" permit the sewage to so fall, flow, or get into the stream. A good defence under this section is, however, that the best practicable and available means are being taken to render the sewage harmless.

5. *FOOD.*

(21.) **Inspection of Food generally.** It is an offence under the Markets and Fairs Clauses Act, 1847, to sell "unwholesome meat or provisions" in a Market or Fair, and any inspector of provisions appointed under that Act may seize such articles and convey them before a justice. The Public Health Act, 1875, has a list of articles as follows:—"Any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk",—which, if they appear to a Medical Officer of Health or Inspector to be unsound, unwholesome, or diseased, may be seized, condemned by a magistrate, and the offender punished by fine or even imprisonment. The list of articles is imperfect, because it omits cheese, butter,

and eggs, but Section 28 of the Public Health Amendment Act extends the application of the Act to all articles intended for the food of man, and upon evidence from any person (sanitary officer or not), a magistrate may condemn unfit food under that section.

(22.) **Milk.** Unsound, diseased, or unwholesome milk may be dealt with by taking it before a magistrate and having it condemned (Public Health Act, 1875, § 117).

Under the Contagious Diseases Animals Acts, 1878–1893, the Local Government Board has power to make general or special Orders: (A) For the registration of dairymen, cow-keepers, or purveyors of milk; (B) For the inspection of cattle in dairies, and regulating the lighting, ventilating, cleansing, drainage, and water-supply of dairies; (C) For securing the cleanliness of milk-stores, milk-shops, and of milk-vessels; (D) For prescribing precautions to be taken for protecting milk against infection or contamination; and (E) For authorizing Local Authorities themselves to make such regulations.

The Local Government Board has exercised its powers in the Dairies, Cow-sheds, and Milk-shops Orders of 1885 and 1886, which deal in considerable detail with the subjects enumerated above.

The Infectious Diseases Prevention Act, 1890, has also a section (§ 4) which was drafted with the idea of giving Medical Officers of Health certain powers of stopping the supply of milk infected, or supposed to be infected, with disease, such as scarlet fever; but the procedure is far too clumsy and long to be of real value.

(23.) **Adulteration of Food.** Adulteration of food is dealt with by the Sale of Food and Drugs Acts, and by the Margarine Act. Under the first-mentioned Acts, samples of food and drink (other than water) can be taken and submitted to a public analyst; on receipt of his certificate, proceedings may be taken should the article be adulterated. The Margarine Act compels the labelling of margarine, and also gives facilities for samples to be taken and analysed.

(24.) **Substitution of Horse-flesh for Beef.** The Sale of Horse-flesh Regulation Act, 1889, compels any seller of the flesh of horses, asses, or mules, for human food, to legibly label their shops or stalls, indicating that they sell horse-flesh. The Act gives special powers of inspection to sanitary officers, and makes it an offence to sell horse-flesh for other meat, or to mix it with other meat without declaring the mixture.

6. *STATUTORY PROVISIONS WITH REGARD TO THE PREVENTION OF DISEASE.*

The statutory powers relating more directly to combating infectious disease are those contained in the Notification and Prevention of Diseases Acts.

(25.) **The Infectious Disease (Notification) Acts, 1889 and 1899.** The Act of 1889 was merely adoptive, but its provisions were incorporated with the Public Health (London) Act, 1891, and, by the Infectious Disease (Notification) Extension Act, 1899, were made compulsory throughout England and Wales. The leading idea of the Act is to compel each medical attendant to immediately certify to the Local Authority every case of infectious or communicable disease specified in the Act; besides the medical man, it is the duty of the head of the family or, in his default, the nearest relative in the building, or the person in charge of the patient, or, in default of all the foregoing, the occupiers of the house, to notify the Local Authority under the same circumstances. The diseases specified are small-pox, cholera, diphtheria, membranous croup, erysipelas, scarlet fever, typhus fever, typhoid or enteric fever, continued fever, relapsing fever, and puerperal fever. The list may be added to temporarily or permanently, in manner provided for by the Act and with the sanction of the Local Government Board.

(26.) **Disinfection.** It is the duty, under Sections 46 and 120, Public Health Act, 1875, of a Local Authority to give notice in writing to the owner or occupier of a house, after infectious disease, to cleanse and disinfect. More often in practice the officers of the Local Authority do this work. In districts which have adopted the Infectious Diseases Prevention Act, 1890, the clerk to the Local Authority has at once to give notice to the owner or occupier, on information received, as to the necessity for disinfection; and there are provisions in that Act ensuring that, within a reasonable time, an infected house or room will be disinfected.

Infected articles may be burnt or otherwise destroyed, but compensation must be given (Public Health Act, 1875, § 121). Local Authorities have power to provide a suitable disinfecting chamber and appliances under the Public Health Act, 1875, § 122.

Owners of public conveyances must have their vehicles disinfected if they have conveyed a person suffering from a dangerous infectious disorder, under a penalty of £5 or less (Public Health Act, 1875, § 127).

An infectious corpse may be conveyed in a hearse but not in a public

conveyance, unless the driver or owner is notified. The conveyance is then immediately to be disinfected (Infectious Diseases Prevention Act, 1890, § 11).[1]

(27.) **The Establishment of Hospitals.** Any Local Authority may provide for the use of the inhabitants a temporary or permanent hospital, not necessarily for the treatment of infectious cases. Two or more authorities may also combine in establishing a hospital (Public Health Act, 1875, § 131). They also have power to establish hospitals in other districts besides their own (*ibid.*, § 285; Withington Local Board *v.* Corporation of Manchester, 9 T. L. R. 206).

A Local Authority may provide ambulances for the conveyance of the sick (Public Health Act, 1875, § 123).

A Local Authority or 25 ratepayers may petition the County Council to provide an isolation-hospital, or cause to be provided a hospital for the treatment of the infectious sick. The Council's duty is then to make a local inquiry. If it is found that the hospital is necessary, the Council makes an order to that effect. Such hospital is managed by a committee, consisting of either the members of the County Council, or partly of representatives of the local area, or wholly of local representatives (Isolation Hospitals Act, 1893). Ambulances are bound to be provided if a hospital of the kind is established (*ibid.*, § 13).

(28.) **Special Statutory Powers with regard to Cholera.** The Local Government Board may from time to time make, alter, or revoke regulations as to the treatment and prevention of cholera or "any other epidemic, endemic, or infectious disease" (Public Health Act, 1875, § 130). Whenever any formidable epidemic or infectious malady actually threatens any part of England (or Ireland), the Local Government Board may make regulations for the speedy interment of the dead, for house-to-house visitation, for the provision of medical aid and accommodation, for cleansing, ventilation, disinfection, and so forth (Public Health Act, 1875, § 134).

The Local Authority has ample power to borrow funds for this purpose (46 and 47 Vict. cap. 59). Two or more Local Authorities may combine for the purpose of dealing with an epidemic (Public Health Act, 1875, §§ 139 and 140). The Local Authority has to carry out any regulations the Local Government Board has made, and certain special powers are given for this purpose (Public Health Act, 1875, §§ 135, 136, and 137).

[1] As stated above, this Act is an Adoptive Act only.

7. *REGULATIONS AND BY-LAWS.*

(29.) **Distinction between By-laws and Regulations.** A large portion of the routine of sanitary administration is enforced by means of "by-laws" and "regulations"; both are local rules made under statutory powers to carry out the details of the law or laws. The essential difference between a regulation and a by-law is mainly in form.

By-laws can only come into force by adopting the exact formal procedure of the particular statute conferring the power of making the by-law, and they must receive the sanction of some higher authority, such, for example, as the Local Government Board. *Regulations*, on the other hand, do not as a rule require any special formalities, and only a few have to receive the sanction of a higher authority.

(30.) **By-laws which "may" or "must" be made by Local Authorities.** By-laws *must* be made by every Local Authority as to common lodging-houses (Public Health Act, § 80), and if Part III. of the Housing of the Working Classes Act has been adopted, Local Authorities *must* make by-laws as to the management, &c., of the lodging-houses under that Act.

Both Rural and Urban Local Authorities *may* make by-laws as to (*a*) cleansing of footways, (*b*) removal of house-refuse, (*c*) cleansing of earth-closets, privies, ash-pits, and cesspools (Public Health Act, 1875, § 44), (*d*) tenement-houses, (*e*) management of mortuaries (Public Health Act, 1875, § 141), (*f*) the decent lodging of hop-pickers, fruit and vegetable pickers (Public Health Act, 1875, § 314, and Fruit-Pickers' Lodgings Act, 1882).

Urban Local Authorities *must* make by-laws with respect to slaughter-houses provided by the Authority (Public Health Act, 1875, § 169).

An Urban Authority *may* make by-laws with respect to nuisances arising from snow, filth, dust, ashes, and rubbish (Public Health Act, 1875, § 44), the prevention of the keeping of animals so as to be a nuisance (*ibid.*, § 44), offensive trades (*ibid.*, § 113), and various matters relating to streets, buildings, chimneys, drainage of buildings, and the closing of buildings or parts of buildings unfit for human habitation (*ibid.*, § 157).

A number of other matters relating to local government can also be regulated in Urban Districts by by-laws (see Public Health Amendment Act, 1890; Public Health Act, 1875, §§ 164 and 197; Towns Police Clauses Act, 1847; Baths and Wash-houses Acts, 1864, 1878; &c.).

8. *STREETS, HOUSES, AND UNHEALTHY AREAS.*

(31.) **Scavenging of Streets, New Streets, Line of Frontage, &c.** Local Authorities may, and when required by the Local Government Board, *must* cleanse and scavenge the streets under their control (Public Health Act, 1875, § 42). The level, width, and construction of new streets, the structure of new buildings, and so forth, may be governed in Urban Districts by by-laws (Public Health Act, § 157).

The lines of streets are preserved by the Public Health (Building in Streets) Act, 1888, and many other matters relating to streets, &c., are regulated by the Towns Improvement Clauses Act, 1847.

Various matters relating to safety in public buildings and streets are also dealt with by the Public Health Amendment Act, 1890, whilst most offences relating to streets are provided against by the Towns Police Clauses Acts, 1847–1889.

(32.) **Structure of Houses—Site of Houses.** By adopting Part III. Public Health Acts Amendment Act, 1890, an Urban Authority can acquire additional powers to make by-laws with regard to the sanitary arrangements of houses, and as to certain matters of structure in the building of new houses. Rural Sanitary Authorities may adopt the same Part III., and then they have the power to make by-laws with regard to the structure of walls, foundations, and floors of new houses. The same Act prohibits the erection of new buildings on ground filled up with matter impregnated with fæcal, animal, or vegetable matter, or upon deposits of such matter, unless such matter has been either removed or rendered innocuous.

(33.) **Unhealthy Houses—Housing of the Working Classes Acts, 1890 and 1903.** A house in such a state as to be unfit for habitation may be closed by an Order of a Court of Summary Jurisdiction. The Order holds good until the house has been made fit for habitation, when it may then be determined by another Order permitting the use of the house (Public Health Act, 1875, § 97). A house also may be closed irrespective of sanitary condition, if two convictions for overcrowding have taken place within three months (Public Health Act, 1875, § 109). Any dwelling-house in a state dangerous or injurious to health *must* be reported upon by the Medical Officer of Health to the Local Authority under the Housing of the Working Classes Act, 1890, Part II., § 30. The County Medical Officer of Health also has the power to make such a representation to any Local Authority, save to the Authority of a Municipal Borough (*ibid.*, § 52).

A Parish Council (Local Government Act, 1894), or four or more householders, may complain in writing to the Medical Officer of Health concerning a dwelling-house. The officer is bound then to inspect and report (Housing of the Working Classes Act, 1890, § 31). Independently of any report or complaint, it is the duty of every Local Authority to cause inspection to be made of their district with a view to ascertain whether any dwelling-house is in an unfit state to be inhabited (*ibid.*, § 32). If on receipt of a representation or information that any house is unfit for habitation, and it appears to the Local Authority that the information is correct, it is then their duty to cause proceedings to be taken to close the house, "whether the same be occupied or not". After closing, provision is made for compelling the repair, or in some cases for demolishing the house. In each case ample opportunity is given for the owner (who under this Act must have at least a 21 years' interest) to be heard, and for him to appeal if he feels aggrieved (*ibid.*, §§ 32–35).

(34.) **Unhealthy Areas.** A Medical Officer of Health on his own initiative, or moved thereto by a complaint of twelve or more ratepayers of the district, may make a representation to the Local Authority that a certain area in an Urban District is unhealthy, and that "the evils are of such a nature that they can only be remedied by an improvement scheme". The Local Authority, "if satisfied with the truth thereof and of the sufficiency of their resources", must then pass a resolution to the effect that the area is unhealthy, and that an improvement scheme should be made (*ibid.*, Part I., §§ 4, 5). The Act provides for full publication of the scheme locally, for a Local Government inquiry, for a Provisional Order confirming the scheme, for the provision of dwelling-accommodation for the families displaced, for compensation of the owners, for the execution of the scheme, and for obtaining loans to carry the scheme out. Small areas may be dealt with similarly under Part II. of the same Act (§ 30), the chief difference being that, if there is no opposition, the Local Government Board may confirm the scheme by Order; otherwise, if there is opposition, the scheme can only be carried into effect by Provisional Order.

The Housing of the Working Classes Act, 1903, extends the period for the repayment of loans from 60 to 80 years (§ 1). In a circular letter (Sept. 22, 1903) the Local Government Board state that they propose in future as a general rule to allow the full term of 80 years for the repayment of money borrowed for the purchase of freehold land, and 60 years for the repayment of money borrowed for the erection of buildings under the Housing Acts. Section 3 imposes the obligation on Local Authorities, companies, or other persons acquiring land under the Housing Acts on which there are dwellings

occupied by 30 or more persons belonging to the working classes, not to enter on such dwellings until the Local Government Board have either approved of a housing scheme or decided that a scheme is not necessary. The same section applies a schedule which sets out in considerable detail various provisions in relation to the making, enforcement, and modification of such schemes. Section 4 enables the Local Government Board to order a scheme to be made; in case of failure to make such scheme, the Order may be enforced by *mandamus*.

Subsequent sections considerably simplify the procedure of putting the Act into force, and in particular enable a confirming Order of the Board to be effective in certain cases without confirmation by Parliament.

Section 8 amends the law with regard to Closing Orders. Under the 1900 Act notice had first to be given to place the premises in repair. In many cases it was well known that the notice would not be complied with. Poor owners are unwilling and often cannot repair a dilapidated house within six months of the termination of a lease. The Act gives power, in cases in which the Local Authority thinks the order cannot or will not be obeyed, to apply to a Court of Summary Jurisdiction and take out a summons for a Closing Order without giving the preliminary notice. When houses are demolished under the Act, and the sale of materials fails to cover the cost of the demolition, the balance can be recovered as a civil debt (§ 9). Section 10 gives a more speedy and efficacious way of recovery of possession of a house in respect of which a Closing Order has been made. New powers are given under Section 11 empowering the Local Authority if they supply lodging-houses, or if they supply housing-accommodation, to provide and maintain in connection with such accommodation shops, recreation grounds, or other buildings or land which in the opinion of the Board might serve a beneficial purpose.

Section 12 renders it impossible for landlords and tenants to contract themselves out of the provisions of the Act of 1900, which makes it a condition in letting a house or part of a house for habitation by the working classes that such house is at the commencement of the holding fit for human habitation.

(35.) **Obstructive Buildings.** Urban Local Authorities possess powers of widening, enlarging, or making new streets, under the Towns Improvement Clauses Act, 1847, § 67, and Public Health Act, 1875, § 154.

An obstructive building—that is, one not necessarily unhealthy in itself, but which stops ventilation, or otherwise makes or conduces to make other buildings to be in a condition unfit for human habitation, or dangerous or injurious to health, or one which prevents proper measures from being carried

into effect for the remedying of any nuisance injurious to health or other evils complained of in respect of such other buildings—is to be reported upon by the Medical Officer of Health, and ample power is given to the Local Authority to purchase the obstructive building and then to pull it down. The Authority may keep the whole or part as an open site, or sell a portion of the site, or may dedicate it as a highway.

9. *FACTORIES AND WORKSHOPS.*

(36.) **The Factories and Workshops Acts.** The Factories and Workshops Acts, 1878–1895, and the Cotton Cloth Factory Acts, 1897 and 1899, are consolidated and amended by the Factory and Workshop Act of 1901. The Factory Acts may also be said to include the Shop Hours Acts, 1892, 1893, 1895, 1904; the Truck Acts, 1831, 1887, 1896; the Quarries Act, 1894; and the Prevention of Cruelty to Children Act, 1894. These acts deal with Factories, Workshops, Domestic Factories, and Domestic Worshops.

(37.) **Textile and Non-Textile Factories—Workshops.** Factories are divided into *textile* and *non-textile.* The definition of "Factory" given in the Acts is long and complicated; it includes a list of various manufactories which under any circumstances are factories, while others such as hat-works, rope-works, bake-houses, lace-warehouses, shipbuilding yards, quarries, pit-banks, and laundries, are "Factories" if steam or other power is employed, but "Workshops" if only manual labour is employed. Outside the list it may be generally stated that trades where no steam or power is employed come under the definition of "Workshop", but those where power is used, under the definition of "Factory". Domestic Factories and Workshops are buildings in which workers dwell who are all members of the same family, and in which no power is used.

(38.) **General Scope of the Factory Acts.** The Acts quoted above deal with overcrowding, ventilation, nuisances, and cleansing or purifying. They regulate the hours of work, holidays, and meal-times; they restrict the employment of children, young persons, and women;[1] they make provision for the education of children legally employed; they provide for escape from fire, and against accidents from machinery, and compel special precautions in certain extra-dangerous trades.

(39.) **Duties and Powers of Local Authorities as to Factories and Workshops.** The Local Sanitary Authority has the duty of inspecting "Workshops and

[1] A "child" is a person under 14, a "young person" above 14 and under 18, a "woman" 18 years of age and above.

Workplaces", whereas "Factories" are inspected by special inspectors appointed by the Home Office; nevertheless the general sanitary state of factories comes under the supervision of the Local Sanitary Authority, besides which a Home Office Inspector is obliged to report sanitary defects to the Local Authority (Factory and Workshop Act, 1901, § 5). It is the duty of the Local Authority to inform the Inspector what measures they have taken to attend to the matter reported to them (Factory and Workshop Act, 1901, § 5), and if the Local Authority have not attended either to this particular complaint, or have failed in any case to abate nuisances in Factories, Workshops, or Laundries, the Secretary of State can authorize the Inspector to take proceedings, the latter then having for that particular case the powers of the Sanitary Authority. On conviction the expenses fall on the Sanitary Authority (*ibid.*, 1901, §§ 4 and 5).

Factories or Workshops in such a condition that any manufacturing process carried on therein cannot be so carried on without danger to health or to life or limb, may be closed by complaint of an Inspector before a Court of Summary Jurisdiction (Factory and Workshop Act, 1901, § 18); or the Secretary of State may make such regulations as "may appear to him reasonably practicable and to meet the necessity of the case". Such regulations have ultimately to be confirmed by Parliament (*ibid.*, § 79–86).

In trades where dust, gas, or vapour is produced or evolved, an Inspector may direct a fan or other mechanical contrivance to be provided (Factory and Workshop Act, 1901, § 74).

Factories have to be cleansed, limewhited, or painted and varnished, at certain periods, unless such processes are for special reasons inapplicable (Factory and Workshop Act, 1901, § 1). Workshops are to be limewashed, cleansed, or purified when necessary, on notice by the Sanitary Authority (Factory and Workshop Act, 1901, § 2).

The minimum cubic space in Factories and Workshops is now definitely fixed at 250 cubit feet per adult, but overtime workers must be provided with 400 cubic feet; these numbers, where other illuminants than electricity are employed, may be revised by the Secretary of State, and also in the case of certain workshops (Factory and Workshop Act, 1901, § 3).

In poisoning by lead, phosphorus, arsenic, or mercury, or infection by anthrax, contracted in a Factory or Workshop, the medical attendant must notify the Chief Inspector of Factories (Factory and Workshop Act, 1901, § 73). Occupiers of Factories, Workshops, or Laundries, or others, must not allow wearing apparel to be made, cleaned, or repaired in any dwelling-house or building occupied therewith, whilst any inmate is suffering from scarlet fever

or small-pox, under a penalty of £10 or less (Factory and Workshop Act, 1901, § 109). Lavatories for the purpose of personal cleanliness are obliged to be provided for workers in lead, arsenic, or other poisonous substances (Factory and Workshop Act, 1901, § 75).

The Secretary of State has issued an Order under Section 9 (Factory and Workshop Act, 1901) determining what is suitable and sufficient accommodation for persons of each sex in Factories and Workshops.

The Order prescribes one sanitary convenience for every 25 males, and the same proportion for females; but there are provisions under which a less proportion is allowed in places employing 100 or more male workers.

The Order does not apply to the Metropolis, but has been taken as a guide by the various London Local Authorities.

(40.) **Bakehouses.** Bakehouses in towns with over 5000 inhabitants are subject to some special regulations with regard to regular limewhiting and cleansing (Factory and Workshop Act, 1901, § 99), with regard to the prevention of persons sleeping on the same level with the bakehouse, in a room communicating directly with the said bakehouse, and for the prevention of any addition to the number of underground bakehouses. A bakehouse must not be used if it communicate directly with a water-closet, privy, or ash-pit. Cisterns supplying water-closets and the bakehouse must be separate, and sewage drains must not have an opening within the bakehouse, the penalty being 40*s.* or less, and 5*s.* a day for continued offence after conviction (Factory and Workshop Act, 1901, § 97).

Should the Home Office Inspector or the District Council obtain a conviction in regard to a bakehouse unfit for use on sanitary grounds, the penalty is for the first offence 40*s.*, and for any subsequent offence £5. The Court may order, in addition to the fine, any necessary work to be done, the penalty being £1 per day for non-compliance with the Order (*ibid.*, § 98).

The walls and ceilings of a bakehouse, together with the passages and staircases, must either be painted with oil, or varnished, or be limewashed, or be partly painted or varnished and partly limewhited. If paint or varnish is used, this must be renewed at least once in seven years, and washed with hot water and soap once at least every six months. Where limewash is used, it must be renewed once at least in every six months (*ibid.*, § 99).

Since January 1, 1904, no underground bakehouse can be used unless the Local Authority have certified that it is suitable as regards "construction, light, ventilation, and in all other respects". No new underground bakehouse can be constructed.

The provisions of the Factory Act with regard to "retail" bakehouses are to be enforced by the District Council and not by the Home Office Inspector (*ibid.*, § 102).

CHAPTER II.

LONDON.

(41.) **Local Authorities in the Metropolis.** The County of London includes the City of London, the City of Westminster, and the Boroughs created out of the old Vestries and District Boards as set out in the first schedule of the London Government Act of 1899 (62 & 63 Vict. cap. 14).

The authorities having sanitary jurisdiction in the Metropolis are:—The County Council, and the Corporations of the City of London, and of the City of Westminster, and of the London Boroughs. The City of London was, until the beginning of the year 1898, governed by the Commissioners of Sewers under rather ancient though still effective sanitary laws, but the Corporation is now the responsible authority.

(42.) **Sanitary Acts in force in the Metropolis.** The special Sanitary Acts in force in the Metropolis and not in force elsewhere, are the following:—The Public Health (London) Act, 1891; parts of the Metropolis Local Management Act, 1855, and its various amendments; the Common Lodging-Houses Acts, 1851 and 1853; the London Building Acts, 1894–1905; the Metropolis Water Act, 1902; and the London County Council (General Powers) Acts, 1902–1903.

The following general Acts are in force in London:—The Housing of the Working Classes Acts, 1890 and 1903; the Factories and Workshops Acts; the Canal Boats Acts; the Local Government Act, 1888; and the Food Acts,—that is, the Sale of Food and Drugs Acts, the Margarine Act, and the Horse-flesh Act.

(43.) **Functions and Duties of the London County Council.** Standing in the place of the old Metropolitan Board of Works, the Council has succeeded to their duties, some of which are as follows:—To deal with the London sewage; to make new *main* sewers when necessary, and to see that local sewers are made in conformity with the general plan of London sewerage; to supervise the lines of frontage; to see to the naming and numbering of the houses; the height of buildings; the width of roads; dangerous structures; the maintenance of open spaces; the structure of theatres and similar public buildings; the registration of dairymen; the registration of houses under the Infant Life Protection Act; the registration and supervision of common lodging-houses; the Shop Hours

Act; the licensing of cow-houses, slaughter-houses, and knackers' yards; the sanctioning of new offensive businesses or otherwise; and the making of by-laws for certain definite purposes, such as the mode of construction of drains; the plan and level of sites for building; the plans, level, width, surface, inclination, and materials for the pavement and roadway of new streets and roads, under the Metropolis Management Acts; and other by-laws under the Public Health (London) Act.

(44.) **Nuisances—"Summary" and "Non-summary".** The Public Health (London) Act, 1891, treats nuisances in a similar way to the Act of 1875, but renders their abatement easier.

Nuisances are not only matters "*injurious*", but "*dangerous or injurious*", to health; they are divided into two classes, which may be conveniently designated "*summary*" and "*non-summary*". Summary nuisances are all ordinary nuisances, such as unhealthy premises, accumulations, overcrowding, animals kept improperly, black smoke issuing from certain chimneys, houses without a proper supply of water, and so forth. Non-summary nuisances are wilful damage or destruction of drains and sanitary appliances; nuisances arising from snow, dust, ashes, &c., in the streets; nuisances arising from offensive drainage from breweries, slaughter-houses, knackers' yards, dunghills, butchers' or fishmongers' shops, or from any manufactory, into any uncovered place; unpaved yards and open spaces; nuisances connected with swine; nuisances connected with offensive trades; and nuisances connected with the filthy state of sanitary conveniences or the approaches thereto.

The chief difference between the two classes of nuisance is one of procedure. Information of a summary nuisance may be given by anyone; it is, moreover, the duty of every relieving officer, and of every officer in the employ of the Local Authority, to give notice of any nuisance which may be brought within his observation, and the Local Authority must make regulations and give the necessary directions so as to ensure this being done. A summary nuisance is to be brought *at once* to the notice of any person who may be required to abate the same, and this is done by a sanitary officer serving a "written intimation". On receipt of information that a summary nuisance exists, it is the imperative duty of the Sanitary Authority to serve a notice on the owner or occupier of the premises, requiring him to abate the nuisance within a specified time, and if the Sanitary Authority choose, they may state the works which are necessary to abate the nuisance (Public Health (London) Act, §§ 3, 4).

(45.) **Metropolitan House-drainage.** The definition of "drain" is slightly different under the Metropolitan laws, for the word "drain" not only includes a

drain for premises within the same curtilage, but also a drain combined with others constructed under the order of any vestry or district board, "as well as any such combined drain laid or constructed before January 1, 1856, pursuant to the order or direction or with the sanction and approval of the Metropolitan Commissioners of Sewers" (18 and 19 Vict., ch. 120, § 250; 25 and 26 Vict., ch. 102, § 112).

The Metropolitan Local Authorities have extensive powers of examining drains to see whether they are in proper order. In case of emergency, they may enter upon any premises with workmen and open the ground in any place they think fit; in other cases twenty-four hours' notice must be given to the occupier (18 and 19 Vict., ch. 120, § 82; Public Health (London) Act, § 40). No complaint need have been laid as to the state of the drain. If Local Authorities so desire, they may examine every house systematically. If the drain is bad, the Local Authority may require the owner to amend it, or may do the work and recover the expense (18 and 19 Vict., ch. 120, §§ 83–85).

Houses without proper drainage, or destitute of drains, must be drained into a sewer, if one exists within 100 feet (*ibid.*, § 73). No new house is to be erected without proper drainage, and full power is given to regulate materials, gradients, and so forth. The foundations of all new houses are to be at such a level as will permit of adequate drainage (*ibid.*, §§ 75, 76).

Local Authorities may make "regulations" as to drains. The London County Council may make "by-laws" to be carried out by Local Authorities.

Foul or improperly-constructed drains constitute a summary nuisance under the Public Health (London) Act, § 2. A drain repaired or constructed in such a way that it is a nuisance, renders the person repairing or constructing it liable to a fine, unless he can show his neglect was not wilful (*ibid.*, § 42). A drain passing under "underground rooms" must be gas-tight (*ibid.*, 96).

(46.) **Metropolitan Water-supply.** The water-supply has been transferred from the Public Companies to a Water Board consisting of representatives of the City, of the London County Council, of all the Metropolitan Boroughs and other bodies interested by the Metropolis Water Act of 1902. There are provisions in the Metropolis Water Acts, 1852 and 1871, compelling the supply of pure water, and the keeping of proper maps showing the position of the mains, &c.

The Water Board must give a constant service, if required to do so by the London County Council; or if, on the representation of a Local Authority, the London County Council neglect this duty, the Local Government Board has the same power. The Board is not bound to give a constant supply, unless the prescribed fittings are provided. Absence of the prescribed fittings is a "summary" nuisance (Public Health (London) Act, § 2).

An occupied house without a proper and sufficient supply of water is a summary nuisance, and a dwelling-house without such supply is to be deemed unfit for human habitation (Public Health (London) Act, § 48). Newly-erected houses, or those which are rebuilt, must have a proper supply of water (*ibid.*, § 48). If the Metropolitan Water Board cut off the supply from any house without giving notice to the Local Authority, it is liable to a penalty of £10 or less.

Polluted wells, tanks, or cisterns, may be closed under Section 54, Public Health (London) Act. By-laws are to be made as to the cleanliness of cisterns and other receptacles for drinking-water (Public Health (London) Act, § 50).

(47.) **Metropolitan By-laws.** A large part of the details of Metropolitan sanitary administration is carried out under the by-laws made by the London County Council, and also under those made by each Local Authority. In this way offensive trades are regulated, the carriage of offensive liquids or matters through the streets, the disposal of refuse, the inspection of cattle and dairies, the construction of sanitary appliances, the occupation of tenement-houses, the cleanliness of tents, vans, sheds, and similar structures, the removal of dung or offensive accumulations, and the abatement of a number of nuisances.

(48.) **Food.** The London Act has a more complete definition of food, extending its scope to "any articles whether solid or liquid intended for the food of man". Ice creams are specially dealt with (London (General Powers) Act, 1902). Ice creams must not be manufactured, sold, or stored in a living or sleeping room, or in a cellar, shed, or room communicating directly with a drain. The commodity must not be exposed to and must be protected from infection or contamination. Notice must be given to the local Medical Health Officer of any infectious disease amongst the persons employed in the business or working in or about the premises, and the itinerant vendor must have his barrow labelled with the name and address of the person from whom he obtains such commodity, or (if he himself makes the cream) with his own name and address; penalty, 40*s.* or less.

(49.) **Provisions with regard to Infectious Disease.** The Infectious Diseases Prevention and the Infectious Diseases Notification Acts are both embodied in the provisions of the Public Health (London) Act. In London it is the duty of the Asylums Board to provide hospitals for the reception of cases of typhus, enteric, and scarlet fevers, small-pox, and diphtheria. A copy of every notification certificate must be sent to the Asylums Board, and to the head-teacher of the school attended by the patient (if a child) or by any child who is an inmate of the same house as the patient.

(50.) **Miscellaneous.** The London County Council registers, inspects, and regulates common lodging-houses under the Common Lodging-Houses Acts, and the London General Powers Act, 1902. A room or house infested with vermin can be cleansed on the certificate of the local Medical Officer of Health (London General Powers Act, 1902).

Filthy, dangerous, unwholesome, or infected articles may be cleansed, purified, or destroyed under a Medical Officer of Health's certificate. Compensation must be given for articles destroyed, and also if articles are unnecessarily damaged (London County Council (General Powers) Act, 1904, § 19).

Houses infested with vermin must be cleansed by the owner or occupier on the certificate of the Medical Officer of Health. Neglect to obey any notice involves a fine of 10*s.* per day, and the Sanitary Authority may do the work at the expense of the defendant (*ibid.*, § 20).

Private sanitary conveniences such as are often attached to public-houses, if constructed so as to be a nuisance or indecent, may be either removed or altered, if notice to such effect be served upon the owner; the penalty for disobedience is £5 or less, and a further fine of 20*s.* per day during continuing default.

When a movable dust receptacle has been provided, the Sanitary Authority may require by notice the owner of the building to remove or fill up any fixed ash-pit. Under certain circumstances the Sanitary Authority may bear part or the whole of the expense of this. The penalty for default is 20*s.*, and a further penalty of 10*s.* per day during continued default (*ibid.*, § 23).

CHAPTER III.

IRELAND.

(51.) **The Principal Acts relating to Public Health in Ireland** are the Public Health (Ireland) Act, 1878; the Public Health (Ireland) Amendment Acts, 1879 and 1896; the Public Health Act, 1889; the Infectious Diseases Prevention and Notification Acts; the Public Health Acts Amendment Act, 1890; the Housing of the Working Classes Act, 1890; the Sale of Food and Drugs Acts; the Margarine Act; the Factory and Workshops Acts; and the Cholera Hospitals (Ireland) Act, 1893. The Sewage Utilization Acts, 1865 and 1867, and the Sanitary Act, 1866, also remain in force so far as they relate to Ireland.

Under these different Acts the duties and powers of Sanitary Authorities and their officers are almost identical with those in the English provinces.

CHAPTER IV.

SCOTLAND.

(52.) **Sanitary Acts in force in Scotland.** There is no inconsiderable body of sanitary legislation common to England, Wales, and Scotland; the Housing of the Working Classes Act, the Rivers Pollution Prevention Acts, the Factory and Workshops Acts, the Sale of Food and Drugs Acts, the Margarine Act, the Contagious Diseases (Animals) Acts, and the Infectious Diseases (Notification) Act, are in force from Penzance to John o' Groats. On the other hand, the Public Health Act, 1875, with its various amendments, the Canal Boats Acts, and the Infectious Diseases (Prevention) Act,[1] do not apply to Scotland.

Scotland, by the passing of the Public Health (Scotland) Act, 1897, now possesses a general health-code in advance of even the Public Health (London) Act. Burghal (*i.e.* urban) populations are also governed by the Burgh Police (Scotland) Act, 1892, save the large towns, Edinburgh, Glasgow, Aberdeen, Dundee, and Greenock, which, under their respective local Acts, enjoy excellent sanitary codes.

(53.) **Sanitary Areas.** The County is primarily the area of jurisdiction for Landward (*i.e.* rural) Sanitary Authorities (Local Government Scotland Act, 1889).

The various Burghal (urban) Districts are comprised under the general appellation of Burghs. There are several kinds of Burghs, such as royal, parliamentary, and police, but the varieties of the Burgh are, so far as sanitary government is concerned, of minor importance.

(54.) **Local Sanitary Authorities.** If a County contains six or more Parishes, the County Council is obliged to divide the County up for the purposes of sanitary administration into Districts, each District to contain a group of Parishes. This power is possessed by all County Councils. In each divided County there are on the average about four Districts, each District containing eight Parishes.

The Local Sanitary Authority for the District is a District Committee, consisting of the county councillors for the electoral divisions comprised within the District, and of one representative from each Parochial Board within the District. The District Committee has, however, only partial authority, as the County Council reserves various powers, such as the power of appointing county medical officers and county sanitary inspectors, of making statutory representations to the Local Government Board for Scotland on matters relating to the

[1] Although the Infectious Diseases (Prevention) Act does not apply to Scotland, its provisions (considerably amended) are embodied in the Public Health (Scotland) Act, 1897.

sanitary state of a District, of making by-laws, and of making general regulations for the government of a District Committee. It has also power to enforce the Rivers Pollution Prevention Acts, and to hear certain appeals.

In eight Scottish Counties which are not divided, the Sanitary Authority is the County Council, and there are of course no District Committees.

In those Burghs which are subject to the provisions of the Burgh Police (Scotland) Act, 1892, the Local Authority consists of the provost, magistrates, and town council, acting as Burgh Commissioners. In other Burghs, the Town Council or Board of Police (as the case may be) is the Local Authority.

(55.) **The Local Government Board for Scotland.** The old Board of Supervision has given place to a Local Government Board for Scotland (Local Government Board for Scotland Act, 1894). The Scotch Local Government Board is presided over by the Secretary of State for Scotland; it includes among its members the Solicitor-general for Scotland, a vice-president, an advocate, and a medical man, and has a staff of clerks, inspectors, and officers. Its powers and duties are analogous to those exercised by the English Local Government Board. It therefore has to do with the administration of the Poor Law, besides the administration of the Public Health and other Sanitary Acts, and certain new duties arising out of the operation of the Local Government Act of 1894.

(56.) **General Duties of Local Authorities.** As under the English General Act, so under the Scotch Public Health Act (Section 17), it is the duty of the Local Authority to make from time to time inspection of their district so as to secure the proper sanitary conditions of all premises within the district. The 149th Section also gives power to abate nuisances in adjoining districts when necessary. "Where a nuisance is situate in a District, the Local Authority of which does not cause the same to be removed, and which nuisance is offensive or injurious or dangerous to another District, the Local Authority of the latter District may call on the first-mentioned Local Authority to take all competent steps for removal of such nuisance, and the said first-mentioned Local Authority shall be bound to do so accordingly, and any expense thereby occasioned to the said second-mentioned Local Authority shall be reimbursed by the first-mentioned Local Authority, the amount of such reimbursement in the case of dispute to be finally determined by the Board."

(57.) **Procedure in the case of a Local Authority neglecting to carry out its Statutory Duties.** If a Local Authority neglects its duty, the following may give written notice to the Local Authority of the existence of such matters requiring attention:—

Any ten ratepayers,

The Parish Council,

The Procurator Fiscal (Public Prosecutor) of the Sheriff Court of the County,

The Local Government Board for Scotland.

Should the neglect be that of non-enforcement of any regulation or direction of the Local Government Board, under Part IV. of the Public Health (Scotland) Act, then in two days,—in other cases fourteen days,—if the matter is not remedied, an application may be made to the Sheriff by summary petition, and the Sheriff shall thereupon inquire into the same, and may require the removal or remedy of the nuisance or the performance of any duty incumbent on the Local Authority, and may enforce his decree at the expense of the Local Authority or of others.

In similar cases, the Scotch Local Government Board has power to apply to the Court of Session with the consent of the Lord Advocate. The Court has in these cases complete jurisdiction. This power has hitherto been only exercised in cases of great importance.

(58.) **Nuisances.** The list of nuisances enumerated in Section 16 of the Public Health (Scotland) Act, 1897, is a far more complete list than the similar lists in the Public Health Act of 1878, or in the Public Health (London) Act of 1891.

Nuisances under the Scotch Act include:—

"1. Any premises or part thereof *of such a construction*[1] or in such a state as to be a nuisance or injurious or dangerous to health:

2. Any *street*, pool, ditch, gutter, water-course, *sink*, cistern, water-closet, earth-closet, privy, urinal, cesspool, drain, dung-pit, or ash-pit so foul or in such a state as to be a nuisance or injurious or dangerous to health:

3. *Any well or water-supply injurious or dangerous to health:*

4. *Any stable, byre, or other building in which any animal or animals are kept in such a manner or in such numbers as to be a nuisance or injurious or dangerous to health:*

5. Any accumulation or deposit, *including any deposit of mineral refuse,* which is a nuisance or injurious or dangerous to health, *or any deposit of offensive matter, refuse, or offal, or manure (other than farmyard manure or manure from byres or stables, or spent hops from breweries) within fifty yards of any public road wherever situated, or any offensive matter, refuse, or offal, or manure other than aforesaid contained in uncovered trucks or wagons*

[1] The portions of the section which introduce matters not definitely classed as nuisances in the English Acts are printed in italics.

standing or being at any station or siding or elsewhere on a railway or in canal boats so as to be a nuisance or injurious or dangerous to health:

6. *Any work, manufactory, trade, or business, injurious to the health of the neighbourhood, or so conducted as to be injurious or dangerous to health, or any collection of rags or bones injurious or dangerous to health:*

7. Any house or part of a house so overcrowded as to be injurious or dangerous to the health of the inmates:

8. *Any school-house*, or any factory which is not a factory subject to the provisions of the Factories and Workshops Acts, 1878 to 1895, or any Act amending the same, with respect to cleanliness, ventilation, or overcrowding, and

(*a*) Is not kept in a cleanly state and free from effluvia arising from any drain, privy, water-closet, earth-closet, urinal, or other nuisance, or

(*b*) Is not ventilated in such a manner as to render harmless so far as practicable any gases, vapours, dust, or other impurities generated in the course of the work carried on therein that are a nuisance or injurious or dangerous to health, or

(*c*) Is so overcrowded while work is carried on, as to be injurious or dangerous to the health of those therein employed:

9. Any fireplace or furnace situated *within the limits of any burgh or special scavenging district*, which does not so far as practicable consume the smoke arising from the combustible matter used therein, for working engines by steam, or in any mill, factory, dye-house, brewery, bakehouse, or gas-work, or in any manufacturing or trade process whatsoever:

10. Any chimney (not being the chimney of a private dwelling-house) sending forth smoke in such quantity as to be a nuisance or injurious or dangerous to health: and

11. *Any churchyard, cemetery, or place of sepulture so situated or so crowded or otherwise so conducted as to be offensive or injurious or dangerous to health.*"

(59.) **Procedure followed to abate a Nuisance.** The majority of the nuisances enumerated are dealt with in a summary manner. The Local Authority serves a notice (Section 20), and if the notice is not obeyed, or if the nuisance is likely to recur, the Local Authority proceeds by "summary petition", or—to use less technical language—a summons is taken out; this is heard before a magistrate, a justice, or the sheriff, and the case is decided and a decree (*i.e.* order) made, and a fine (not exceeding five pounds) may be inflicted, the whole procedure only differing in details from that followed in the other parts of the kingdom. In the majority of cases such "decrees" are final, there being

no appeal, but Sub-sections 6 and 8 of Section 16, relating to factories, businesses, and schools, can only be enforced on application to the sheriff, and then only (i) on medical certificate, or (ii) on a representation by a Parish Council, or (iii) on a requisition in writing under the hands of any ten ratepayers of the district. The smoke sub-sections and nuisances connected with graveyards can only be compulsorily abated by the sheriff (Sub-sections 9, 10, and 11 of Section 16).

If with regard to these latter nuisances the cost of effectually abating or dealing with them is certified by the sheriff to be above £25 and under £50, there is a power of appeal from the sheriff-substitute to the sheriff; exceeding £50 there is a power of appeal from a judgment of either the sheriff-substitute or the sheriff to the Lord Advocate, and in certain cases from the Lord Advocate to the Inner House (Section 156).

There is in Scotland an additional and useful power to deal with nuisances by by-laws. County Councils have power, subject to the sanction of the Secretary of State, to make by-laws "for prevention and suppression of nuisances not already punishable in a summary manner by virtue of any Act in force throughout the county". Burgh Commissioners may, with the approval of the Local Government Board for Scotland, or of the sheriff, make by-laws for preventing nuisances in any street or in any other place within the Burgh, and also for various other sanitary purposes under Section 318, Burgh Police (Scotland) Act.

During the year 1895 eight applications were made to the Scotch Local Government Board under the before-mentioned section. Three of these related to slaughter-houses, two to water-supply, two to the drainage of houses, and one dealt with the cleansing of common stairs, &c.; these were confirmed so far as they related to sanitary matters.

(60.) **Offensive Trades.** The Scotch classification of offensive trades is as follows:—"The business of a blood-boiler, bone-boiler, manure-manufacturer, soap-boiler, tallow-melter, knacker, tanner, tripe-boiler, gut or tripe cleaner, skinner or hide-factor, slaughterer of cattle or horses, or any other business which the Local Authority may declare, by order confirmed by the Board and published in the *Edinburgh Gazette*, to be an offensive business". Such businesses may neither be established, nor existing ones enlarged, without the sanction of the Local Authority, if they are situate within five hundred yards from any burgh or village. Such businesses may be regulated by by-laws. In a Burgh, the Commissioners have also the power of making by-laws with regard to offensive businesses, whether they are newly established or not.

(61.) **Water and Water-supply.** The words "lands" and "land" in the Lands Clauses Act, and in the Public Health (Scotland) Act, include water and the right thereto: which definition facilitates much the provision where necessary of a public water-supply by the Local Authority. The Secretary for Scotland is empowered to issue provisional orders putting in force the Lands Clauses Acts with regard to water-supply and drainage. In Landward (rural) Districts, the Local Authority may provide for the whole District a water-supply, and in that case the water-rate falls upon the whole District. The Local Authority may also take a smaller area, and, forming it into a Special District, give a supply, and the rate then falls only on the District benefited. It appears to be necessary, in forming a Special District, that the Local Authority shall be first moved by a requisition of ten inhabitants, and if there is opposition and an appeal is taken, then the consent of the sheriff is necessary

Towns or Burghs requiring a water-supply, and no water-company existing and willing to supply the water, may take advantage of the powers either under the Public Health (Scotland) Acts, or under the Burgh Police (Scotland) Act. Under the first-named Acts, the Local Authority of a Burgh with a population of 10,000 or more, or having a local Police Act, may provide a water-supply themselves, or contract with a water-company. In Burghs under 10,000, or in any Burgh where the local Police Act makes insufficient provision, the Lands Clauses Acts may be made use of, and, if necessary, the compulsory powers of those Acts may be applied by provisional order. The Burghal Authority may purchase the undertaking of a water-company, or contract with the company, but must not compete with it.

The Burgh Police Act only applies to Burghs which have not been supplied with water before 1895 under a local Act or Acts. It enables the Burgh Commissioners of a Burgh with a population below 5000, to apply the compulsory clauses of the Lands Clauses Act, with the consent of the sheriff and without provisional order, for the purposes of a water-supply.

With regard to the water-supply of individual houses, the Public Health (Water) Act, 1878, does not apply to Scotland, but Section 125 of the Public Health (Scotland) Act, 1897, provides that "if any occupied house within the District of any Local Authority is without a proper supply of wholesome water at or reasonably near the same, the Local Authority shall require the owner to obtain such supply, and do all such works as may be necessary for that purpose"; on failure, they may themselves obtain such supply, recovering the whole or part of the expense in a summary manner. The Local Authority may also execute works for a joint-supply to two or more houses, and apportion the

expense. The Local Authority has also the same general duties and powers as under the English Acts with regard to water-supply.

In Burghs an owner may be compelled to supply water *within* the house.

(62.) **Pollution of Drinking-water.** A polluted supply of drinking-water is made a nuisance, to be abated summarily, as previously detailed, Section 16 (3).

Under Sections 127–129, Public Health (Scotland) Act, any person engaged in the manufacture of gas, naphtha, vitriol, paraffin, or dye-stuffs, or any other deleterious substance, or in any trade in which the refuse produced in any such manufacture is used, who shall at any time cause or suffer to be brought, or to flow into any water used for domestic purposes, any product, washing, or other substance produced in such manufacture, or wilfully do any act to pollute any such water, shall forfeit for every such offence a sum not exceeding £50. The defaulter is also liable after twenty-four hours' notice by the Local Authority, or the party aggrieved, to a fine of £5 per day during which the pollution continues. As before mentioned, the Rivers Pollution (Prevention) Act is in force in Scotland.

(63.) **Sewers and Drains.** There is no essential difference between Scotch and English powers in the provision of public sewers, and in dealing with sewage.

As to the drainage of houses, it is enacted that "if a house, distillery, manufactory, or other work is without a drain, or without such drain as is sufficient for effectual drainage", a drain must be provided, connected either with a cesspool or a sewer, Section 120.

(64.) **Powers with regard to the Prevention of Disease.** The Infectious Diseases Notification Act is now extended to every part of Scotland (Public Health (Scotland) Act, 1897, Section 44), and the Infectious Diseases Prevention Act, although not in force as a separate statute, has been embodied in the new Public Health Act, but with several important amendments.

A medical officer may enter and inspect at reasonable times in the daytime any house or premises in his district, in which he has reason to believe that any infectious disease exists, or has recently existed, and medically examine any person found on the premises. Obstruction is dealt with in the usual way (Public Health (Scotland) Act, 1897, Section 45). Local Authorities may provide disinfecting appliances, and, if required to do so by the Board, must provide such appliances. The procedure with regard to the cleansing and disinfecting of premises in cases of infectious disease is similar to that under the Public Health (London) Act (*ibid.*, Section 47).

Persons engaged in washing and mangling clothes may be required to furnish a list of the names and addresses of their customers to the Local Authority, the

Authority making a small payment for the same (*ibid.*, Section 49). A similar list of customers may have to be furnished by dairymen, where there are good grounds of suspicion that an outbreak of infectious disease is associated with a particular milk-supply, as well as the names and addresses of farmers, dairymen, or other parties, from whom they have had the milk (*ibid.*, Section 61).

The isolation of cases of infection likely to be dangerous to the public is ensured by an important amendment in the wording of the older law:—"Any person suffering from any infectious disease, who is without proper lodging or accommodation, or is so lodged that proper precautions cannot be taken for preventing the spread of the disease, or is lodged in a tent or van, or in a room occupied by others besides those necessarily in attendance on such person, or is on board a ship", may be removed to hospital (*ibid.*, Section 54). In cases of outbreaks of infectious disease connected with particular milk-supplies, the sections borrowed from the Infectious Diseases Prevention Act are amended so as to make the action of the Local Authority and the sanitary officers fairly prompt (*ibid.*, Section 60). The rest of the Scotch law with regard to infectious disease scarcely differs from that in force in districts under the Public Health Act of 1875.

(65.) **Provisions as to Buildings.** Previous to the passing of the Public Health (Scotland) Act, 1897, the burghs under the Police Act and the large towns alone could deal with the sanitary appliances and the structure of new buildings. In the other parts of Scotland a nuisance from faulty construction could be abated, but not inhibited; this is now remedied by the new Act.

I.—Burghs. A special feature in Scotland is a court which the Commissioners of every Burgh have a right to establish, under the name of the "Dean of Guild Court"; this court is a very ancient institution, one of its functions being the supervision of the construction of buildings and of sanitary works. The Dean of Guild Court is practically a Works Committee of the Local Authority, and the important functions of this supervision are often discharged by the Guild Court.

New buildings have to be constructed with a damp-proof course, the gables and party walls must be solid and the walls impervious to damp, the mortar must be good, and the plumbing work must be tested. Before a new house is built, or before an old house is altered, petitions containing full details as to the proposed building or proposed alterations must be lodged before the Commissioners. All rooms in new or altered houses must be efficiently lighted and ventilated from the street, or from an open space representing three-fourths of the area on which the house stands. Not more than twelve flats may open from

an inside stair, nor more than twenty-four from an outside stair. There are provisions for adequate height of rooms, and for window-space. The erection of buildings on improper sites, such as ground impregnated with fæcal matter, is prohibited, and no new house can be occupied in a Burgh until a certificate of fitness for occupation is issued by the Burgh Surveyor.

II.—New powers given by the Public Health (Scotland) Act to Local Authorities other than Burgh Commissioners. By Section 181, Public Health (Scotland) Act, the Local Authority of any district other than a burgh may, subject to the approval of the County Council, make by-laws for the whole or any part of their district for regulating the building or rebuilding of houses or buildings, or the use for human habitation of any building not previously so used, or any alteration in the mode of occupancy of any existing house, in such a manner as will increase the number of separate houses, in respect to the following matters:—

(*a*) The drainage of the subsoil of sites and the prevention of dampness in houses intended for human habitation;

(*b*) The structure of walls, foundations, roofs, and chimneys of new buildings, in so far as likely to affect human health;

(*c*) The ventilation of houses and buildings intended for human habitation;

(*d*) The sufficiency of the space about buildings to secure a free circulation of air;

(*e*) The construction and arrangement of the drainage of houses and buildings, and of soil-pipes and waste-pipes, and the construction and position of water-closets, earth-closets, privies, ash-pits, cesspools, dung-steads, slop-sinks, and rain-water pipes and rhones;

(*f*) The production of suitable building-plans in respect of the matters mentioned in this section, and their inspection;

(*g*) The intimation previous to the commencement, by the owner or person laying out the work, to the Local Authority, of the date of the commencement, and for the due inspection (in respect of the matters mentioned in this section) of houses or buildings in process of erection or alteration, and the examination of the drains thereof, and for the pulling down, alteration, or amendment of any work which has been carried out in contravention of the by-laws;

"In making such by-laws, the Local Authority shall have regard to the special circumstances of their district, or the part thereof to which such by-laws relate."

Under Section 182 it is made illegal to erect new buildings on any ground which has been filled up "with any matter impregnated with fæcal, animal or vegetable matter, or upon which any such matter has been deposited, unless and until such matter shall have been properly removed by excavation or otherwise or shall have been rendered or have become innocuous". The penalty for default is £5 or less, and a daily penalty not exceeding 40*s*.

APPENDIX

SPECIFIC GRAVITY AND ABSORBENT CAPACITY OF BUILDING-STONES

COMPILED BY THE EDITOR

No.	Description of Stone.	Specific Gravity.	Specific Gravity of Particles.	Absorption of Water per Cent in				
				1 Sec.	1 Min.	30 Mins.	1 Day.	1 Week.
	Oolitic Limestones.							
1	Purbeck	2·45	2·64	·21	·65	1·75	2·41	2·85
2	Purbeck-Portland	2·45	2·68	·76	1·91	3·83	4·02	4·21
3	Chilmark (*Brown Bed*)	1·86	2·42	8·82	10·78	10·78	11·37	12·54
	,, (*Hard Pinney Bed*) ...	2·06	2·52	2·53	5·90	7·38	7·80	8·86
4	Ham Hill	2·11	2·50	1·30	3·47	6·30	6·52	7·17
5	Doulting	2·17	2·56	2·47	5·30	5·83	6·30	6·89
6	Bath (*Coombe Down*)	1·77	2·49	2·63	7·00	12·57	13·15	16·37
	,, ,, ...	2·10	2·43	·73	2·44	5·62	5·86	6·35
7	Farleigh (*Oaty Bed*)	2·00	2·61	1·76	5·58	10·29	10·58	11·76
8	,, (*Fine-grained Bed*) ...	1·84	2·65	4·33	13·66	15·33	15·33	16·66
9	Corsham (*Bottom Bed*)	1·95	2·68	3·16	8·97	12·92	13·19	13·98
10	,, (*Corngrit*)	2·09	2·67	1·47	4·66	9·09	9·58	10·29
11	Painswick	2·09	2·63	2·24	6·50	8·96	9·41	9·86
12	Weldon	2·07	2·43	6·81	7·03	7·03	7·03	7·03
13	Ancaster (*Weather Bed*)	2·44	2·63	·40	1·00	2·61	2·81	3·01
14	,, (*Freestone Bed*)	2·24	2·64	1·54	4·20	6·19	6·19	6·63
	Magnesian Limestone.							
15	Mansfield, Yellow	2·36	2·58	·61	1·02	2·66	3·07	3·48
	Kentish Rag.							
16	Ightham	2·56	2·65	·18	·37	·56	·94	1·30
	Sandstones.							
17	White Mansfield	2·31	2·55	·68	1·14	2·99	3·66	4·11
18	,, ,, (*another quarry*)	2·22	2·50	2·19	3·40	4·13	4·62	5·10
19	Red Mansfield	2·25	2·49	·90	1·81	4·07	4·07	4·29
20	Grinshill, Shropshire (*Triassic*) ...	2·04	2·38	2·43	5·20	5·90	6·25	6·94
21	Corsehill (*Permian*)	2·18	2·48	1·25	2·50	4·38	4·80	5·42
22	Scotgate Ash, Pateley Bridge (*Carboniferous*)	2·21	2·48	·72	2·16	3·84	4·32	5·04
23	Fishponds, Bristol (*Carboniferous*)	2·61	2·70	—	—	·19	·76	1·15

INDEX.

NOTE ON

"MODERN HOUSE CONSTRUCTION"

Though this Work has been issued in six divisions, it was planned to make two volumes, and has been paged accordingly. Thus VOL. I is made up of the first three divisions, which are paged consecutively; and VOL. II comprises divisions 4, 5, and 6. The references in the index are therefore to the complete volumes, **not** to the divisional volumes. The work is also issued in two volumes.

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